Wind Tunnel Operations Division

Test Planning Guide
for
High Speed Wind Tunnels

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Ames Research Center,
Moffett Field, California

Record of Changes

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List of Acronyms and Abbreviations

Term	Definition
AEDNS	Ames Engineering Document Number System
AHB	Ames Handbook
AMM	Ames Management Manual
ANSI	American National Standards Institute
ARC	Ames Research Center
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CCB	Configuration Control Board
CDR	Critical Design Review
CM	Configuration Management
CMP	Configuration Management Plan
CR	Change Request
CSI	Construction Specification Institute
DSA	Document Submittal Authorization
ECO	Engineering Change Order
EDC	Engineering Documentation Center
FFC	Fast Field Change
FMM	Facilities Management Manual
IST	Integrated System Test
NASA	National Aeronautics and Space Administration
NHB	NASA Handbook
NMI	NASA Management Instruction
ORR	Operational Readiness Review
PCA	Physical Configuration Audit
PDR	Preliminary Design Review
PLC	Programmable Logic Controller
PR	Peer Review
QA	Quality Assurance
SME	Subject Matter Expert
SOP	Standard Operating Procedures
SDS	Standardized Data System

Term	Definition
TWT	Transonic Wind Tunnel
WT	Wind Tunnel

1.0 Introduction

Purpose of This Test Planning Guide

The purpose of this guide is to acquaint customers with the requirements for conducting tests in any of the Wind Tunnel Operations Division's high-speed test facilities at Ames Research Center. It includes available services and capabilities of these facilities and standard practices/procedures to enable customers to achieve their test objectives.

Wind Tunnel Availability

The Wind Tunnel Operations Division high speed wind tunnels are available for Government sponsored and commercial customers. Approval to conduct test programs must be justified on the basis of technical merit, national priority, and the capability of the Ames facilities to meet the test requirements.

Results from all tests are in the public domain and available for general distribution unless the data is proprietary by fee basis or classified by a Government sponsor.

List of Facilities

The Wind Tunnel Operations Division is responsible for the operation of the following high-speed facilities located at the Ames Research Center.

- 9x7ft Supersonic Wind Tunnel
- 11ft Transonic Wind Tunnel
- 12ft Pressure Wind Tunnel

Inquiries

Inquiries regarding the use of these facilities should be directed to:
Wind Tunnel Operations Division
Chief Wind Tunnel Operations Branch
Mail Stop 227-3
Ames Research Center
Moffett Field, CA 94035
Phone: (415) 604- 6698

Document Control

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2.0 Pretest Requirements

Initial Requests

The initial contact to request a wind tunnel test is Chief, Wind Tunnel Opera;tions Branch. The contact should be made during the early stages of test program development (7 to 12 months before tunnel entry date) to discuss projected schedules and general requirements and concerns for tests in Ames Research Center tunnels.

Early notification will allow personnel to review the proposed test and to ensure that test requirements are compatible with the requested test facility and that schedule constraints can be addressed.

Requesting Tunnel Time

The following sequence of events should begin well before the desired test dates (7 months in requested) to be included in the wind tunnel test schedule:

- The test sponser/customer contacts the Wind tunnel Operations Branch Chief.
- The customer completes and submits a Test Request form. See Appendix C for a copy of this form. It is also available electronically in Microsoft® Word. Upon receipt of the Test Request at Ames, a process to accommodate the test begins.
- A Test Objectives Meeting is scheduled to discuss the overall test requirements and the Ames facilities capablilities to meet these requirements.

2.1 Test Objectives Meeting

Purpose

The purpose of the Test Objectives Meeting is for the customer (or test sponsor) to discuss the subject test requirements with Ames/ Wind Tunnel Operations Division personnel to determine if the Ames facilities can meet the test objectives. When the required facility is heavily booked, the customer will be required to provide information supporting the urgency of the test.

Scheduling the Meeting

The Test Objectives Meeting will be held as soon as possible after the initial request and preferably 6 months prior to the proposed test start date.

Typical Meeting Agenda

The Test Objectives Meeting covers:

- purpose, scope, and criticality of test.
- test objectives.
- initial instrumentation requirements.
- initial controls requirements.
- initial data reduction software requirements.
- estimated test run matrix.
- any special or unusual test requirements.
- hardware fabrication requirements.
- security requirements.

Test Acceptance

When the test program is accepted:

- the customer is notified
- a test date is scheduled
- a Test Manager is assigned, who functions as the principal point of contact between the customer and NASA
- a Initial Test Planning Meeting is scheduled
- resources are committed to support the test
- a space act agreement may be required

2.2 Initial Test Planning Meeting and Test Requirements Document (TRD)

Purpose

The purpose of the Initial Test Planning Meeting is to discuss details regarding test requirements. The Test Manager and customer develop detailed plans together, and then management is briefed. The meeting is held nominally 12 weeks prior to the test. See Appendix C for recommended guidelines for the Initial Test Planning Meeting.

Test Requirements Document

The Test Manager must receive a complete TRD from the customer at least one week prior to the Initial Test Planning Meeting. See Appendix C for an outline of the TRD. The document covers the following areas:

- Description of Test Objectives
- Model Hardware Requirements
- Instrumentation Requirements
- Data Processing Requirements
- Security Requirements (if applicable)

Description of Test Objectives

As part of the TRD, NASA requires a clear statement of the test objectives and techniques to achieve those objectives. Any special techniques or procedures should be explained. The customer must provide a prioritized run schedule compatible with the objectives and allotted test time.

Model Hardware

The TRD must provide drawings of the model, installation, and appropriate hardware to adapt the customer-supplied model to the tunnel or existing Ames equipment. Gauges or jigs can be made available to the customer and they will be sent on request. The customer is to return them within three weeks of receipt. All models tested require a supporting stress analysis. See Section 5.2 for details.

Instrumentation Requirements

The TRD must provide instrumentation requirements and demonstrate how the customer will adapt customer-supplied instrumentation to the wind tunnel data system. Ames will specify the required type of plugs, connectors, etc.

Data Processing Requirements

Data reduction information (data inputs, equations in engineering language, data output format complete with units and scaling for accuracy and resolution) must be submitted to the Test Manager.

Customers must request subsequent changes to these data requirements in writing to the Test Manager for review and approval.

Security Requirements (if applicable)

The TRD must address in specific detail security requirements for model prep room, test section, control room, model access, photography/video, data acquisition, and data processing.

2.3 Customer Agreement

Description

At the conclusion of the Initial Test Planning Meeting or as soon as possible thereafter, the NASA Test Manager will develop a detailed Customer Agreement. This document describes the Division’s and Customer’s deliverables with appropriate milestones and dates identified. The document will address the following items as appropriate:

- Introduction and background of test

- Test milestone dates
- Estimate of time required to accomplish test matrix and objectives
- Goals and objectives of test
- Customer and division points of contact (Initial Test Planning Meeting attendees)
- Overall requirements (model, model support, facility, instrumentation, computing)
- Test conditions and type(s) of data required
- Design reviews /additional requirements meetings
- Deliverables/due dates prior to test dates
- What the customer will provide in support of the test and when
    - equipment, hardware, fabrication
    - labor resources
    - analyses
    - model
    - any unique requirements for verification, storage, or maintenance of customer supplied products
- What the Division will provide in support of the test and when
    - equipment, hardware, fabrication
    - labor resources
    - analyses
    - facility dependent model hardware

The Customer Agreement will be signed by the Division and Customer representatives, distributed to all affected parties, and the original will be archived within the Division.

If during further test preparations significant changes in the Division’s or Customer’s responsibilities, deliverables, or milestones are deemed necessary, these changes will be managed according to the Test Change Control Process as defined in the Wind Tunnel Operations Division Test Process Manual. The Test Manager and Customer representative will agree on the changes, the Test Manager will determine the appropriate level of Division Management involvement, and an addendum to the Customer Agreement will be created and signed by both the test Manager and the Customer representative.

2.4 Model and Equipment Delivery

Timely Arrival

Models and support hardware should arrive at the tunnel at least one week prior to the scheduled model preparation room entry. The Test Manager will provide appropriate shipping addresses.

Arrangements can be made to ship the model several weeks prior to the test if necessary.

Preassembly Requirements

All model parts, internal instrumentation, and customer-provided support hardware must be assembled and checked out by the customer prior to delivery to Ames to ensure proper fit, and form and to reduce installation delays.

Shipping Information

Immediately following shipment from the customer's plant, the Test Manager must be notified of identifying shipping numbers and scheduled arrival time. Shipments must be prepaid and arrive on the specific day agreeable to the Test Manager.

- Models shipped via common carrier should be addressed to: (Name of Test Manager), Ames Research Center, Moffett Field, California, 94035
- The Test Manager's name, telephone number, delivery point, and the test number must be marked on the boxes.
- Large boxes are required to have skids at least 4 inches thick so they can be handled using a forklift.
- Deliver models brought via customer's private trucks directly to the testing facility.

Identification or Unsuitability of Customer Equipment

Model and test equipment delivered shall have appropriate identification that designates the contractor’s ownership of the equipment. The identification of the equipment shall be maintained while the equipment is at Ames. This is especially important for equipment that stays at Ames long after a test is completed.

If a customer supplied model or test equipment is damaged or found unsuitable for its intended use, the Test Manager will document the condition and archive the findings. The customer will be notified and corrective actions will jointly be determined by the Test Manager and customer.

3.0 General Information

Primary Point of Contact

The Test Manager functions as the primary point of contact to facilitate requests, requirements, services, and standard procedures for the customer while at Ames Research Center.

Communications

Telephones, FAX machines, and Internet access are available.

Cafeteria Hours

The Ames cafeteria is open from 6:00 a.m. until 2:00 p.m. Monday through Friday.

Office Space

Private office space is not available in the control room but desk and filing space are provided. During preparation and testing, desk space may be available in the model buildup area.

Visitor Control

Visitor Control is located in Building 26, which is located on the right side of the Moffett Boulevard Main Gate. Business hours are from 7:00 a.m. to 4:30 p.m., Monday through Friday. All Ames visitors are required to obtain temporary badges at Visitor Control. Arrivals other than normal business hours must make special arrangements through the Test Manager.

3.1 Security

Advance Notification Requirements

The customer must provide the Test Manager with a list of names and citizenship of all customer personnel who will require entry into Ames for the duration of the test. The times below are the advance notification requirements.

Table 3-1: Advance Notice Requirements

Category of Visitor	Advance Notice Required
U. S. Citizen	None
Non-U.S. Citizen (nontechnical)	10 days
Non-U.S. Citizen (technical)	5 weeks
Non-U.S. Citizen (employment) (contracts, grants, etc.)	9 weeks; Must have a valid passport and visa in his/her possession
Classified visit	10 days

If these lead times are not adhered to, delays, inconveniences and test stoppage can result.

Secret or Confidential Clearances

If the visit is Secret or Confidential, visitors are required to have their security clearances sent in advance to:

NASA/Ames Research Center
Attn: M/S 253-1, Visitor Control
Moffett Field, CA 94035-1000
(415) 604- 5590

Badges

While at Ames, all customer personnel are required to wear badges as issued by Visitor Control. The Test Manager is responsible for coordinating with the customer how and when to obtain badges and their applicable requirements (i.e. for second and third shifts, etc.).

Signing In

Upon arrival, all customers are requested to sign in with the assigned Test Manager. They are to provide local addresses and telephone numbers so calls and correspondence may be directed to the proper place.

3.2 Planning

Normal Operating Hours

Test facilities are operated on a normal five-day week beginning 11:30pm Sunday until midnight Friday. Consult the Test Manager regarding the specific shift hours because they vary between test facilities.

Off-Shift Coverage

Access to the test facility on shifts other than operating shifts must be coordinated through the Test Manager. Customer personnel are not permitted to work in the facility without facility personnel present.

Test Safety Review and Test Debriefing

A test safety review is held just prior to beginning test operations to review operations and safety aspects of the test and facility. This includes test objectives, run schedule, instrumentation, hardware, and stress limitations.

Just prior to the completion of the test, the customer's senior Test Manager will meet with NASA management for the purpose of evaluating the quality of the test support received by the customer.

The Test Manager will make the arrangements for this meeting.

Charges for Test Time

The occupancy time charged to the customer starts at the beginning of the installation of the test hardware in the test section and concludes with the restoration of the facility to its pretest configuration. The customer's equipment must be crated and ready for shipment at the completion of the test period.

Schedule extensions can only be made by the Assistant Division Chief for Wind Tunnels at the request of the Test Manager.

Computation of Test Time

The time required for installation and test run, or test-run series, is dependent on several factors:

- the quality of test preparation
- the specific model
- the time to complete model changes
- test facility
- test conditions
- number of runs required
- number of data points
- and conditions changed between data points

Customers should consult the Test Manager about the time required to complete a test program. See also Table 3-2.

3.3 Support

Requests for Assistance

All requests for assistance or services must be made to the Test Manager or shift engineer.

As a customer, please provide Test Managers with clear, complete, and timely requirements to ensure adequate and effective test support can be provided.

Model Buildup

Final details of model preparation and Ames support required during buildup must be established with the Test Manager at least one week prior to the customer's scheduled arrival.

Some of the wind tunnels have no designated buildup area, so the customer may be required to build up in a remote location with little or no shop facilities. In this case, the customer must come fully equipped with tools and supplies to function without outside assistance. All fabrication and subassembly of the model must be done prior to arrival at Ames.

Customer Responsibility

Customers provide their own mechanics to perform model changes. All tools, spare parts (including certified fasteners), and supplies necessary for personnel to work on the model and any special equipment not available at the particular tunnel are supplied by the customer. A competent aerodynamicist familiar with the model and test objectives must be accessible during the test. The customers may request the use of NASA personnel to assist in model changes.

Government Equipment

Customer personnel are not to operate government-furnished equipment or to make connections to this equipment. Such equipment includes, but is not limited to,

- instrumentation
- data processing and recording equipment
- facility control equipment
- pressure regulating and measuring equipment
- electrical and pressure disconnect panels
- overhead cranes

Shop Services

Ames shop services are available to the customers and must be requested through the Test Manager.

Photographic Services

Photographs of the model and installation are taken to the extent necessary to document the test. Additional photographic requirements should be discussed with the Test Manager prior to the test.

Balance Availability and Calibration

The Division Balance Calibration Laboratory has a Sandberg-Serrell balance calibration semiautomatic loading machine capable of calibrating balances between 2 and 4 inches in diameter. The machine can load a single gauge or a combination of up to six gauges. The lab staff also performs balance hand-loading.

To assist with scheduling and to ensure availability, customers must consult the Test Manager during the initial test planning meeting if planning to use an Ames balance or if requesting calibration for a customer balance.

Time Estimates

The following table lists some typical times (in minutes) for how long it takes to complete various tasks.

Table 3-2: Task Completion Times

	Wind Tunnel		
Activity	**11ft**	**9x7ft**	**12ft**
Close Tunnel (Prior to Drive Start)	10	10	10
Pump Tunnel to Limit Pressure from 1 Atmosphere	30	20	plenum 4 circuit 60
Pump to Tunnel Limit Vacuum from 1 Atmosphere	30	15	plenum 4 circuit 20
Dry Tunnel Air *****	45	30	—
Start Tunnel Drive	5	5	5
Set Initial Tunnel Conditions	10	10	10
Time for Typical Data Point	2	1	1
Change Test Conditions (M, Pt, rpm, m, IGV angle, etc.)	5	10	5
Stop Tunnel Drive	5	5	5
Blow Down to Atmosphere from Tunnel Limit Pressure	10	10	plenum 4 circuit 10
Model Configuration Changes	function of the model and change required		
Start-of-Operating Period Inspections and Activities	120	120	daily 30 weekly 90
Post Operating Period Inspections and Activities	30	30	30
Drive Compressor Blade Insp. (every 25 hrs. of running time)	120	—	90
Rotate Flow Diversion Valves	—	60	—
Uncouple/Couple Drive Motors	45	45	—
Plant Equipment Warm-Up	120	240	20
Plant Equipment Cool-Down	120	240	—

***** Only necessary when continuous purging system is not functioning

4.0 Environment, Health and Safety

Description

This section acquaints the Customer with the Wind Tunnel expectations concerning emergencies, safety, and hazards. Procedures, controls, and guidelines are described to ensure the Customer understands what is required to protect personal safety, the facility and environment, and to reduce associated risks to acceptable levels. The Test Manager, or in their absence the Shift Engineer, has the responsibility for and authority to take all steps that are necessary during test planning, preparation, execution, and closeout to ensure the safety of personnel, equipment, and the facility.

4.1 Emergency Information

Emergencies

For any emergency, **dial 911** from a site phone or 650-604-5555 from a cellular or off-site phone, to reach the Ames Dispatch. Report the nature and location of the incident, and stay on the line. Appropriate response personnel will be dispatched immediately. The Ames Test Manager will discuss specific emergency and evacuation procedures with Customer personnel at the beginning of the test.

Evacuation

When the evacuation alarm sounds (a very loud buzzer), all persons shall leave the building immediately through the nearest safe exit in an orderly manner. After evacuating the building, report to your Ames Test Manager or Shift Engineer at the designated assembly area and do not leave unless authorized to do so. Evacuation maps are posted on each floor of every building.

Customers must advise the Test Manager of special needs for any planned visitor who is disabled before they arrive on site. This will ensure that appropriate actions are taken in advance to ensure their safety during their visit to Ames.

Fire

Evacuate immediately. Fire alarm pull stations are strategically located for emergency use. Call **911** from a safe location. Do not use elevators. If possible, close doors to slow spread of fire and limit smoke damage. If heavy smoke is present, stay low. Fire extinguishers are available for small fires in all work areas, but do not use one unless you have first called **911** and have been trained to use it.

Earthquake

Should an earthquake occur, choose a safe place (under a sturdy desk or table, and away from glass, machinery, and chemicals), drop, cover, and hold on. Do not run out of the building. Once the shaking has stopped, proceed with caution to your assembly area and be prepared for aftershocks.

Injuries and Treatment

Dial **911** (or **650-604-5555** from cellular) for emergency treatment of injuries occurring at Ames Research Center. The closest emergency facility is the El Camino Hospital emergency room at 2500 Grant Road in Mountain View. During the day shift, first aid treatment is available at the Ames Health Unit located across the street from the north entrance to the cafeteria. First-aid kits can be found at many strategic locations in the work areas.

Personal Illness

Treatment for personal illness must be obtained at medical facilities in one of the local communities. El Camino Hospital (650-940-7000) in Mountain View offers a referral service.

4.2 Wind Tunnel Hazards

General

The Test manager will discuss the hazards peculiar to the facility and the particular test with all personnel, at the beginning of the test.

Aerial Lifts

Only authorized and trained persons shall operate any aerial lift on site. Proper fall protection equipment shall be used during operation.

Confined Spaces

Many of the work locations within the wind tunnel meet the OSHA definition of non-permit or permit-required confined spaces (permit-required will be labeled as such). All entries into a confined space will follow the Wind Tunnel Confined Space Program and the Wind Tunnel Entry Procedures contained in the SOP. The Test Manager will brief test personnel on any special entry requirements at the beginning of the test.

Cranes/ Lifting Devices

Due to Ames training and certification requirements Customer personnel may not operate facility overhead cranes and hoists unless they are specifically authorized to do so by Wind Tunnel Operations Division Management. Personnel shall keep a safe distance away from lifting operations.

Electrical

At the Wind Tunnels there is medium voltage at ground floor and power service panels (480, 220, 120, 120/208 volts). The wind tunnel test section, plenums, and air stream circuit are completely grounded with many metal surfaces which increase the potential for electric shock. To minimize this risk only electric cords and equipment that are in good physical and working condition will be allowed in the facility. In addition, equipment shall be powered through Ground-Fault Circuit Interrupter (GFCI) protected electrical outlets, or through the use of in-line GFCI devices.

Ergonomics

Avoid repetitive motions and heavy lifting. Get help or mechanical aid for heavy lifts. Adjust the work station to your physical needs to reduce

	strains and injuries.
Fall Protection	Anyone on site working from an unprotected elevation of six feet or more above the ground or next lower level, or who may fall into hazardous equipment, shall use appropriate personal fall protection equipment. This includes while traveling, stationary, or at anytime exposed to a fall from a surface not protected by a standard guardrail or other approved fall prevention device. Personal fall protection equipment shall only be used by personnel who have completed the appropriate training.
High Pressure	High pressure air up to 3000 psi and hydraulic systems are present in the Wind Tunnel. Personnel entering the wind tunnel during tests that utilize these utilities may be required to follow Division lock and tag requirements as directed by the Test Manager.
Lead	The wind tunnels have many aged surfaces containing lead paint. Assume paint contains lead unless otherwise proven. Do not disturb painted surfaces unless previously authorized to do so. Dusty areas may contain lead dust from deteriorated paint. Limited on-site work activities using lead include soldering, welding, cutting and grinding. Always wash hands before eating, drinking or smoking. Eating and drinking in shop areas is prohibited.
Lock-out/Tag-out	Our policy is to prevent an undesirable release of hazardous energy during any servicing, maintenance or modification activity. The Wind Tunnel Division LO/TO procedures shall be strictly followed whenever it is necessary to work on any equipment that may release any form of hazardous energy including, but not limited to, electrical, rotational, mechanical, chemical, hydraulic or pneumatic energy. Visitor locks and tags are readily available from the Test Manager or Shift Engineer and must be used during LO/TO operations.
Mechanical	Rotating equipment and moving parts in the Wind Tunnel, such as the model support system, roll mechanisms, and the kick sting can cause compression, collision, pinching, impact or crushing hazards.
Noise	All personnel must wear hearing protection when entering a designated noise-hazard area. Visitor earplugs are placed in strategic locations. Noise levels adjacent to equipment areas can be elevated and in some cases may reach greater than 100 dB(A).
Sharp Edges	Models installed in wind tunnels may have sharp cutting edges that should be covered each time personnel enter the wind tunnel for model work.

Trips, Bumps, and Falls

The Wind Tunnels have high numbers of cords, cables, conduit, piping and other obstructive structures. Take special care when maneuvering through close quarters and areas with equipment.

Wind Tunnel Entry

Most portions of the wind tunnels including the test section, wind tunnel circuit, and test section plenums, etc. meet the OSHA definition of confined spaces, therefore, all entries into the wind tunnel are controlled by facility personnel. Access to the test section is usually allowed without special controls; however, access to other areas generally requires the application of locks or tags to secure the facility, equipment, or systems in a safe configuration. Work activities within the wind tunnel beyond the test section must be coordinated with and approved by the Test Manager before work commences.

Working Alone

The term "working alone" means that an individual is in a work location, environment, or situation that will prevent others from observing and communicating verbally with them unless steps are taken to establish a means of remote communication. The primary risk of concern for those working alone is that they will become injured or ill and will not be able to perform a self-rescue, or be able to summon required assistance. It is not practical or desirable to eliminate all instances of working alone. For example, single individuals on flexible schedules may work alone in offices or control rooms before or after regular business hours, and craftsmen may conduct rounds while alone on swing or grave shifts. However, steps must be taken in all instances to ensure that Customer and facility personnel identify the risks posed by working alone, and manage them to an acceptable level. Personnel may not work alone when the activities they will be performing or the environment they will be performing them in pose higher than normal risks. Examples of such activities include:

- Entering permit-required confined spaces.
- Entering the wind tunnel plenums.
- Entering the wind tunnel circuits.
- Working in any wind tunnel test section.
- Breaking connections on, or pressure testing hydraulic or pneumatic systems with operational pressures exceeding 15-psig, excluding shop air and instrument air up to 140 psig in lines and not exceeding 1-inch in diameter.
- Conducting work where an individual may come in contact with un-insulated, energized electrical equipment or components having a potential greater than 50-volts.
- Operating or conducting maintenance on unguarded equipment that poses mechanical, point of operation, or mechanical power transmission hazards, such as adjusting or performing functional tests.
- Conducting work requiring the use of life-saving safety equipment, such as personal fall-arrest or restraint equipment

and supplied air respirators.
- Using or working around unenclosed Class IV lasers.
- Working with dangerous quantities of hazardous materials.

All instances requiring working alone shall be discussed with and approved by the Test Manager.

4.3 Hazardous Materials

Definition

Hazardous materials are defined as any materials having properties that may result in risk or injury to health, destruction of life or facilities, or harm to the environment. Hazardous materials, as defined, include, but are not limited to, toxic, flammable, combustible, corrosive, asphyxiating, reactive, and explosive materials. Other hazardous material examples are compressed gases, oxidizers, reproductive toxins, carcinogens, irritants, and sensitizers.

Beryllium Alloys

The machining, filing, sanding, and polishing of metal alloys containing Beryllium is strictly prohibited in all NASA Ames facilities.

Material Safety Data Sheets

The Customer must provide the Material Safety Data Sheets (MSDS) for all Customer-supplied hazardous material, regardless of quantity, at least 4 weeks prior to test date.

Hazardous Material Approval Process

The Test Manager shall provide the Division Safety Office with the Customer's proposed MSDSs 4 weeks prior to test date. The Wind Tunnel Division Safety Office shall approve proposed hazardous materials operations and procedures before work begins. The Ames Safety Office will be notified when a material that may present a hazard to persons or has the potential to harm the environment will be introduced into the workplace. After approval, MSDSs shall be maintained at the worksite during the duration of tests.

Labels

As a minimum, all hazardous material containers must be legibly labeled with the name of the chemical or product that it contains and the hazards the material poses to personnel (such as toxic, corrosive, flammable, etc).

Operations Involving Hazardous Materials

The basic premise for ensuring safety during any operation involving hazardous materials is that the individuals involved have an adequate understanding of the specific:

- Hazards, warning signs, and symptoms
- Precautions to be taken
- Procedures for handling emergencies

Gaining this understanding must be accomplished before starting operations and should be an important consideration in planning the work. This means that every operation must be thoroughly screened for safety, and all personnel must be made aware of the hazards, precautions, and procedures for handling hazardous materials and responding to accidents and other emergencies before the proposed activities begin.

Customer-Generated Hazardous Waste

Any waste generated by the Customer must be stored and labeled appropriately. The Customer shall remove their generated hazardous waste from Ames unless prior arrangements are made with Ames waste operations.

Spills

Notify the Test Manager of any hazardous material spills immediately. If appropriate, 911 will be alerted for any reportable spill (potential risk to health or environment). Assist in evacuation and deny entry to affected area. Small spills that are not reportable (no potential risk to health or environment) can be controlled without external assistance if spill response materials and PPE are available and persons are trained. Do not go beyond your level of competence.

4.4 Protective Equipment

General

Customer personnel must be equipped with hearing protection, safety glasses, safety shoes, appropriate gloves, and any other protective equipment justified by the nature of the work. Emergency eyewash fountains are located at each facility. The Customer shall provide training necessary to perform their work with the protective equipment in a safe manner.

4.5 Personnel Training

General

Customer personnel are responsible for having the necessary training and knowledge to understand the job hazards and their controls. Prior to arrival, they shall be trained in all tasks involved in the Wind Tunnel proposed operations in which they may participate. Such training may include Hazard Communication, Confined Space Entry, LOTO, Fall Protection, Cranes, Aerial Lifts, Forklift, Lead Awareness, PPE, Back Injury Prevention, Laser, UV, and/or Electrical Safety. The Wind Tunnel Division Health & Safety Manual and the Ames Health & Safety Manual are excellent sources for additional information on training requirements at this Facility.

4.6 Laser Safety

Safety Standards

The use of lasers at Ames is governed by the "Standard American National Standards Institute (ANSI) Z136.1 for the Safe Use of Lasers" and the Ames Health and Safety Manual, Chapter 8. The Test Manager coordinate with Center personnel as required to assist Customer personnel in meeting the requirements contained in these documents.

Approval Authority

The Ames Laser Safety Officer (LSO) must evaluate and approve all laser installations and operations. Approval must be coordinated through the Test Manager.

Authorized Laser Customers

Authorized Laser Customers are responsible for compliance with safety regulations in the operation of their equipment, and:

- Are responsible for ensuring that personnel using lasers under their supervision are properly instructed and trained (within the last 2 years).
- Must establish and maintain a current list of all personnel authorized to operate specific types of Class III and IV lasers under their direction.

Safety Eye Wear

Safety eye wear designed to filter out the specific wavelength characteristic of the laser affords adequate protection only if properly prescribed and utilized. Safety eye wear should be evaluated periodically to ensure its integrity. There should be assurance that eye wear designed for protection from specific lasers is not mistakenly used with lasers of different wavelengths. The specific optical density at appropriate laser wavelengths of the filter plate should be printed on the eye wear.

Required Ophthalmologic Exam

All authorized personnel who work with Class 3b and Class 4 lasers shall have a base-line eye examination for visual acuity prior to beginning work with a laser system.

4.7 Other Safety Guidelines

Bloodborne Pathogens

Be aware that if any injury or accident occurs, do not clean up blood since there may be a potential exposure to bloodborne pathogens. Notify your Test Manager or Shift Engineer immediately for assistance.

Equipment

All equipment will be inspected prior to operation and tagged out if damaged.

Housekeeping

There shall be no hazardous accumulations of combustible trash and debris. Access must be maintained for all exits, electrical panels, and

	fire protection panels. Corridors and stairways shall be kept clear of obstacles. Equipment and material will be stored in a stable configuration. Working and walking surfaces must be dry, smooth, and free of clutter.
Permits	Any activities involving hot work (e.g., welding, cutting, burning, brazing), generating solvent vapors into the air, entering a confined space, or disposing of industrial waste water, must be permitted prior to activities. Contact the Test Manager for more information.
Postings	All visitors shall abide by area signs and postings.
Storm Drains	Nothing is allowed to pass through the storm drains but rain water.
Vehicles	The speed limit on the Ames Facility is 25 mph unless otherwise posted. Ames Security is responsible for enforcing federal and state driving laws. Vehicles shall be parked only in authorized parking spaces.

4.8 References

The following Ames documents contain further information on environmental, health and safety issues.

- SOPs—Each wind tunnel has documented Standard Operating Procedures that contain safety and emergency shutdown procedures
- Division and Branch Safety Plans—General safety procedures and guidelines
- Division Environmental SOP—Environmental procedures and policy
- Building Emergency Actions Plan (BEAP) for the building being occupied located in each lobby
- Division Health & Safety Manual is available through the Division's external web page at http://windtunnels.arc.nasa.gov
- Ames Health and Safety Manual (APR 1700.1)—Center parent document on all safety issues at http://q.arc.nasa.gov/safetymanual/
- "Standard American National Standards Institute (ANSI) Z136.1 for the Safe Use of Lasers

5.0 Risk Assessment and Safety Review Requirements

Introduction

Wind tunnel testing inherently involves potential hazards that could affect personnel, equipment, or test progress.

Controlling these hazards is essential to ensuring personnel, equipment, and test operations are protected from harm and that the facilities operate to their fullest capacity. Therefore, model and associated equipment design and operation must incorporate safety principles presented in this document.

The Ames Health and Safety Manual describes procedures used to ensure equipment and systems are designed and operated safely.

5.1 Risk Assessment

Overview

The risk associated with conducting a test is a function of the hazard's severity and the likelihood or probability that the hazard will actually be encountered.

The Ames Health and Safety Manual describes in general terms how the risk of hazards should be identified and mitigated. The Wind Tunnel Operations Division has further refined that process and adapted it to wind tunnel testing and operations as described in the following paragraphs.

The Customer is responsible for preparing the Risk Assessment, following guidelines presented in this document, and presenting the results of the assessment at the Initial Test Planning Meeting.

The Division may request, based on the Risk Assessment, that a Hazards Analysis be performed. This may be done by the customer or by the Division's System Safety Analyst or a combination.

First, hazard severity is assessed, then probability, then these factors are considered together to determine the final risk. Finally, hazard controls are implemented to decrease or control the risk.

Hazard severity There are four hazard-severity categories as described in the following table.

Table 5-1: Hazard-Severity Categories

Category	Definition
I Catastrophic	• Death or permanent debilitating injury • Possible tunnel down time in excess of three months • Possible equipment or facility damage above $500,000 • Definite serious violation of operational criteria if test objectives are to be met; waiver required
II Critical	• Disfiguring injury or lost time greater than three months • Possible tunnel down time between one and three months • Possible equipment or facility damage between $50,000 and $500,000 • Possible serious violation of operational criteria if test objectives are to be met
III Marginal	• Lost-time injury greater than one day • Possible tunnel down time of less than one month • Possible equipment or facility damage between $10,000 and $50,000 • Operational criteria compromised in a minor way
IV Safe	• No lost-time injuries • Tunnel down time less than one week • Possible equipment or facility damage less than $10,000 • No violations of any operational criteria

Hazard probability There are four hazard-probability levels as described in the following table.

Table 5-2: Hazard-Probability Levels

Level	Description	Probability of occurrence
A	Probable—Likely to occur several times during the life of the system or test period	0.1 to 1.0
B	Remote—Likely to occur once during the life of the system or test period	0.01 to 0.1
C	Improbable—Not likely to occur during the life of the system or test period	0.001 to 0.01
D	Highly improbable—Occurrence is considered to be extremely unlikely during the life of the system or test period	0.0 to 0.001

These risk severity categories and probabilities must be considered together to determine the final risk evaluation. Different levels of risk require different management approval, as described next.

Risk Assessment Approval

The matrix below shows who is responsible for authorizing the risk acceptance for each combination of severity and probability. These sign-off authority requirements apply to Test Readiness Reviews (TRRs), Operational Readiness Reviews (ORRs), and Hazard Reports that result from system safety analyses of test installations and facility modifications.

Table 5-3: Risk Assessment Approval levels

	Probability Level			
	A	B	C	D
Hazard Category	Probable	Remote	Improbable	Highly improbable
I Catastrophic	Center Director			
II Critical				
III Marginal		FO Division		
IV Safe				FOO Branch

Hazard Controls

The Ames Health and Safety Manual describes the order of preference for controlling hazards. The Wind Tunnel Operations Division also implements controls for facility and test hazards following this order of preference, summarized as follows.

1. Design for Minimum Hazards—Provide inherent system safety by selecting appropriate design features and qualified components.
2. Incorporate Safety Devices—Includes mechanical barriers or inhibiting mechanisms. Conduct periodic functional checks of such safety devices.
3. Incorporate Protective Systems—Includes fire suppression systems, radiation shielding, flash shields, containment, etc.
4. Incorporate Warning Devices—Includes signals, lights, signs, horns, etc., and include requirements for training to ensure a proper and timely response to warning devices.
5. Institute Special Procedures—Include emergency procedures that effectively limit initiating a hazardous sequence. Includes caution and warning statements in normal operating procedures. A formal Operational Hazards Analysis will be required for all

deviations from the Standard Operating Procedure (SOP) Manual for each facility.

5.2 Model Safety Requirements

Stress Report

A stress report is normally required for all models to be tested in the WInd Tunnel Operations Division facilities. See Section 5.3, Design Criteria-Reduced Requirements, and Section 5.5, Model Acceptance Criteria-Waivers, for limited exceptions to this requirement. The stress report establishes that the model has met all structural requirements. It should be complete and sufficiently comprehensive to preclude further explanation.

The Test Manager and customer personnel negotiate the delivery schedule for the stress report and other documentation at the Initial Test Planning Meeting. The report is due no later than 6 weeks prior to the tunnel entry date.

Stress Report Changes

Design evolution could dictate changing stress report content after decisions made at the Initial Test Planning Meeting. Negotiate changes with the Test Manager.

Stress Report Contents Overview

In the following order, the report must contain (as a minimum):

1. A table of contents.
2. Documentation of load envelopes. Steady-state aerodynamic loads and thermal loads for extremes of test conditions. Include starting loads for the 9x7ft wind tunnel.
3. A summary of the expected stresses and safety factors.
4. A discussion of the sources of design loads and the methods used to determine them.
5. The stress analysis (see next section).
6. Drawings of the model configuration, support components, and the model as installed in the tunnel.
7. Quality-inspection reports to validate the integrity of the completed model.
8. Documentation of stability requirements (see section 5.3, Design Criteria, for details on the stress analysis).
9. Frequencies and estimated dynamic loads on model for dynamic and transient testing.

Other Requirements

Ames might also require other items such as:

- material certification
- calibration data
- dimensional certification
- operator certification
- detailed design drawings to validate the integrity of the completed model
- weld certification

These items are normally requested at the Initial Test Planning Meeting, if required.

Formal Design Review

Formal design reviews are not normally required of models to be tested in the Ames facilities. The Test Manager can, however, require design reviews for those designs that are especially complicated and potentially hazardous.

5.3 Design Criteria

Overview

This section describes design criteria, specifically:

- Stress Analysis
- Material Selection
- Allowable Strength
- Structural Joints
- Pressure Systems
- Electrical Equipment
- Model Support Systems

Stress Analysis

Stress Analysis Overview

The stress analysis must include, but is not limited to, the following elements:

- An analysis showing that all models, including mountings and emergency restraint systems, are statically and dynamically stable and free from divergence throughout the model test envelope (refer to Model Support Systems near the end of section 5.3).
- Aerodynamic derivatives used in the analysis, their source, and a discussion of the consideration given to effects of Reynolds number, Mach number, surface condition, etc.

- Source and range of mass and inertia parameters, including cross-coupling terms such as I_{XZ} and support-system stiffness coefficients.
- Parametric variations of significant design variables; i.e., tension-to-weight ratio, center-of-gravity location, pulley locations, etc., to establish sensitivity.

Stresses or Loads

Allowable stresses are the lessor of the material ultimate stress divided by a safety factor of 4, or the material yield stress divided by a safety factor of 3.

The stress analysis is to show that allowable stresses or loads are not exceeded for the worst load case, including but not limited to:

- Dynamic factors that could result from separated flows in wakes, on model surfaces or components, etc.
- Thermal stresses due to factors such as cold or preheated air used in some propulsion tests
- Stress concentration factors
- Wind tunnel starting loads
- Maximum operating loads

Forces and Moments

Each detailed analysis section should contain a sketch showing forces and moments acting on the part and a statement of:

- Assumptions
- Approximations
- Section properties
- Type and heat treat condition of the material
- Pertinent drawing number

General Equations

In all calculations, the general equations and their source must be given before substituting numerical values.

Air-Loaded Surfaces

Give shear and moment distribution diagrams resulting from worst-case pressure distribution.

Section Properties

Define section properties of the structural member for shear, axial load, bending, and torsion at an adequate number of stations to facilitate a check on the location of the designated critical sections.

Air Loads

All parts with lifting surfaces (such as vertical stabilizers, pylons, and struts) that are designed for operating only at zero angle of attack must be checked for air loads of ±2 degrees.

Static Test Instead of Stress Analysis

Static tests may be accepted in lieu of a stress analysis under the following conditions:

- If the load on the component in question can be directly and continuously monitored, the stress tests will be carried to twice the predicted operating load, and measured deflections must not indicate a permanent deformation. These tests must be witnessed by facility personnel.
- If the load on the component in question cannot be directly and continuously monitored (for example slats, ailerons, elevators, rudders, flaps), the static test must be carried to three times the predicted load without permanent set.
- Following static testing, nondestructive inspection techniques are required to validate the structural integrity of the component.

Gauged Components with Stress Analysis

If the load on the component in question can be directly and continuously monitored, a safety factor of three (3) or greater, calculated using the allowable tensile stress (F_{tu}), is required in the stress analysis.

Reduced Requirements

If the model safety factors cannot be met (4.0 for ultimate and 3.0 for yield), contact the Test Manager to discuss the possibility of reducing (waiving) these requirements. Examples include tests of actual flight components, dynamically similar models, or aeroelastic models. Compensation for the safety factor reduction could include additional instrumentation, closely monitoring critical areas, provision of safety catches, or special proof loadings.

The provisions of this paragraph can only be implemented by waiver approval. See also section 5.5, Model Acceptance Criteria.

Previously Tested Components

Stress analysis must be submitted for all components to be tested in Ames facilities, even if they have been tested at Ames before. The customer must revise previous stress reports of previously tested models to incorporate any new worst-case loads for each component.

Material Selection

Materials Standards

Where applicable, materials are to be selected using mechanical properties and other specifications in the latest issue of one of the following standards:

- ASTM Specifications
- MIL-HDBK-5, Metallic Materials and Elements for Aerospace Vehicle Structures.
- MIL-HDBK-17, Plastics for Flight Vehicles

Mechanical Properties Corrections

All mechanical properties used must be suitably corrected for

- Temperature
- Pressure
- Other environmental effects that might be present when the material is under stress

Allowable Strength

Safety Factors

Except for gauged elements (previously discussed), safety factors of 4.0 on ultimate and 3.0 on yield must be maintained on parts and hardware. Plastic bending analysis is not accepted.

Refer to the Ames fastener guidelines later in this section. Also, if desired, contact the Test Manager for a current copy of the NASA Ames Research Center Fastener Supplier list.

Shear Stresses

If the shear ultimate strength of the material is unknown, calculate it as 60 percent of the tensile ultimate strength.

Thermal Stresses

Any thermal stresses that could occur must be algebraically subtracted from ultimate tensile and tensile yield strength of materials before the factors for allowable stresses are applied.

Material Properties

Material stress properties should reflect the expected minimums that will occur within the expected temperature range.

Buckling Stress

The allowable compressive stress in columns and skins must be equal to or less than one-third of the critical buckling stress.

Oscillating Stresses

Allowable oscillating stresses caused by oscillating loads with or without accompanying steady-state loads must be computed as follows:

- The mean stress, if any, must be applied to the proper Modified Goodman Diagram to which a safety factor of four (4.0) has been applied.
- The gross allowable oscillating stress must then be obtained from this diagram.
- The allowable oscillating stress must be obtained by dividing the gross oscillating stress by the appropriate stress concentration factor, if any.

Impact Strength

All material must have a minimum Charpy V impact strength of 15 foot-pounds at test conditions.

Structural Joints

Fastener Quality Standards

The models tested in theWind Tunnel Operations Division wind tunnels must be assembled using high-quality fasteners of SAE grade 5 or more.

Ames requires using certified fasteners; if used exclusively and proof of certification is supplied to the Ames Test Manager in the form of a Certified Material Test Reports (CMTR), no further checking will be required. If a CMTR cannot be provided, then all noncertified critical bolts will be removed from the model for examination and Rockwell hardness verification during test installation.

Fastener Assembly

Critical fasteners must be assembled using a calibrated torque wrench. The fastener manufacturer's torque specification will be used if the full-rated strength of the fastener is required to maintain Ames required safety factors.

Structural Joint Drawings

Drawings for all structural connections must list the following:

- Strength and quality of fasteners
- Torque values for tightening screws and nuts
- All welded, soldered, brazed, bonded, or other nonbolted, structural-connection techniques must be listed, showing locations on drawings and exact fabrication specifications, as well as analyzed in the stress report

Mil Spec Standards for Joints

Joining components (including tubing) by methods other than welding, soldering, or bonding is to be accomplished as appropriate in compliance with military specification standards.

All joints must be inspected using the appropriate nondestructive inspection technique decided upon by the customer and Ames personnel.

At NASA's discretion certain joint designs located at critical load-carrying sections might not be permitted. Soft-soldered joints are not acceptable. Silver-soldered joints might be acceptable, depending on application.

Welded Joints

All welded joints must be designed and fabricated in compliance with the code of the American Welding Society. All welds must be verified by appropriate inspection techniques such as, but not limited to, magnetic particle inspection, X-ray, or dye penetrant methods.

Critical welds (those whose failure would result in model or facility damage) must be analyzed in the stress report. Include inspection certification as an addendum to the stress report.

Shear Loads (bolted joints)

Shear loads must be transmitted by keys, pins, pilots, or shoulders.

Bolt Preload

For bolt preload in bolted structural joints:

- Use manufacturer’s recommended value.
- Avoid oscillating stresses in threads.

Thread Engagements

Critical fastener thread engagement with nuts and/or tapped holes must be sufficient to develop strength equal to the fastener or to the application design load with the appropriate safety factors applied.

Countersinks, Counterbores and Spot Faces

Model countersinks will be inspected during the test installation period to ensure that they are cut concentric to the threaded hole, have the proper countersink angle, and the fastener heads seat properly in the countersinks.

Counterbores and spot faces will likewise be inspected to verify that the contact surface does not bend or pry on the fastener body when it is tightened.

Small Screws

Fasteners of size #4 or less that are removed during a model change must be replaced with a new fastener.

Screw Joints

To assure tight joints between parts joined by screws, screws and threaded connectors must be sufficiently torqued to provide loads greater than the expected maximum separating forces.

Bolted Joints

Bolted joints with the primary function of transmitting moments must be designed in such a manner that the bolt preload divided by the joint contact area is at least 1.25 times the applied moment divided by the section modulus of the contact area.

Any bolt torque values that are different from the published vendor data must be derived in the stress analysis.

Fastener Locking

All structural bolted or screwed connections must be provided with positive mechanical locks such as:

- Locking inserts
- Self-locking-type nuts
- Safety wiring (drilled heads must be provided)
- Fastener adhesive such as Loctite (within rated temperature)

All bolted and screwed connections must meet these requirements, even if the connection is to be repeatedly disassembled during testing (e.g., changes in flap deflections).

Pressure Systems

High-pressure Air Availability

Most Wind Tunnel Operations Division facilities can supply up to 3,000 psi heated air with various burst disk capacities.

Pressure-Relief Devices

Relief devices are required in the system (but not necessarily in the model) and must be capable of discharging the full flow of the pressure source under all conditions including those resulting from malfunctions.

Users are to inform the Test Manager on the requirements of the maximum and minimum pressures the model can withstand to determine system burst disk pressures. Users must provide pressure relief devices appropriate to the model as required. If rapid air discharge constitutes a noise hazard, mufflers are required on discharge lines.

Users should check with the Test Manager to verify the appropriate burst disks are available; otherwise customers must supply their own.

Pressure System Codes

Models, support equipment, and test equipment using hydraulic, pneumatic, propulsion, or other systems with operating pressures above 15 psig are to be designed, fabricated, inspected, tested, and installed to comply with the following codes and definitions:

- ASME Boiler and Pressure Vessel Code
- ASME B31.1 Power Piping Code
- ASA Codes as sponsored by ASME
- Department of Transportation Regulations

Pressure System Components

Definition
The components of a pressure system include

- vessel
- relief devices
- piping

Testing/Storage
Pressure components that have been proof-tested must be stored in a clean, dry, sealed condition with controlled accessibility.

Identification
All pressure system components (including piping) are to be indelibly marked in a conspicuous place with sufficient information to determine:

- Part number
- Proof test pressure
- Working pressure
- Date of proof test
- Volumes and temperature range

Certification
All pressure system components must have current certification

(valid throughout the test). Certifications are required annually. A certification report must be submitted for all tested systems.

Pressure Vessel

Definition
All shells, test chambers, tanks, and model parts designed for internal pressures greater than 15 psig are considered pressure vessels.

Design
Pressure vessels must be designed in compliance with the latest edition of the ASME Boiler and Pressure Code, Section VIII or Section III.

Welding
Pressure-vessel welding must be in compliance with the ASME Boiler and Pressure Code as follows:

- Section IX for welding qualifications
- Section V for welding inspection

Pressure Piping

All piping must be designed, fabricated, inspected, tested, and installed in compliance with the latest edition of the ANSI Standard Code for Pressure Piping.

Tubing to Powered Models
For powered models, the internal supply tubing is considered pressure piping.

Piping in Pressure Vessels
Pressure vessels fabricated from standard pipe, standard pipe fittings, and standard flanges are also considered pressure piping. They are defined as those covered by these ANSI dimensional standards**:**

- Pipe: B.36.10 and B.36.19
- Fittings: B.16.9
- Flanges: B.16.5

Welding
Welders, welding operations, and welding procedures are to be qualified in compliance with Section IX, ASME Boiler and Pressure Vessel Code, except as modified by the applicable section of the Piping Code.

Threading
Allowances must be made as required or recommended by the Piping Code for pipe threading, corrosion, and wall thinning due to pipe bending.

Threaded Pipe Joints
Threaded joints, flange joints, and seal welding of threaded joints must be in compliance with the requirements and recommendations of the Piping Code.

Tube Fittings
Tube fittings must be in compliance with the latest issue of applicable Military Standards.

Service Line Identification
All service lines must be properly identified for working pressures, flow direction (in or out), and fluid or gas carried.

Electrical Equipment

General

All electrical devices and wires used in the test section must be capable of withstanding the test section environment.

Material Criteria

Use only qualified hardware or equipment and material conforming to the National Electrical Code. Wires and cable require good abrasive resistance. All wiring is to be identified in accordance with schematic and wiring diagrams by using color coding, bands, tags, etc.

Fuses and Shielded Wires

Protect electric circuits with proper fuses. Pressure transducers, strain gauges, vibration pickups, and other low-voltage devices should have each set of wires shielded. Also use shielded wiring with high-voltage and AC devices. Determine the required size, type, and length of wiring at the pretest conference.

User-Furnished Electrical Materials

The customer should provide the following electrical devices as discussed at the Initial Test Planning Meeting and required by the test.

- Control panels and/or control boxes required to operate model components.
- Control panel leads of sufficient length to make proper connections in the respective control rooms.

- Mating electrical connectors for any customer-furnished equipment requiring connectors at interfaces located at control boxes in and/or at the model.
- Electrical schematics, wiring diagrams, and hookup sheets for model and control panels with the model design drawings in compliance with documentation requirements.

Documentation should be provided to the Test Manager 4 weeks before the start of the test.

Model Support Systems

Specification

An adequate margin of bending and torsional stability must be shown for models and model support systems and must meet the following divergence criteria:

$$\frac{dN/d\alpha}{dF_{SS}/d\Theta} < 1/2$$

For all test conditions and configurations, the ratio of model airload increase due to a change in angle of attack ($dN/d\alpha$) to the support system restoring force generated by such an angle change ($dF_{SS}/d\Theta$) must not exceed one-half.

Aerodynamic Interference

The customer, after consulting the Test Manager, is responsible for providing a design that reduces aerodynamic interference to minimum acceptable limits, including models to be tested on Ames-furnished stings.

Model Support Hardware

Any customer-supplied hardware must be fit-checked and forwarded to Ames for verification at least 6 weeks before the test date. Taper fits must have at least 80 percent evenly distributed contact on each land. A report of fit-check results must accompany the hardware (see Appendices A, B and C). Taper fits will be verified at Ames using the fluorescent oil technique described in Appendix A.

If customer hardware is to match with Ames gauges, the gauge(s) will be provided at the customer's request by the Ames Test Manager.

An inventory of model support hardware available at Ames is listed in Appendix B.

5.4 Model Fabrication Requirements

General

The customer is responsible for having models fabricated and assembled in compliance with:

- Design drawings and specifications
- Model safety requirements (see section 5.2)
- Design Criteria (see Section 5.3)
- Inspection and tests established by the Test Manager (see Section 5.5)

Model Assembly

Models are to be completely assembled for all test configurations at the manufacturer's plant and discrepancies corrected before shipment to ensure that:

- All model parts fit properly.
- Model loading fixtures have proper fit and have been certified for the required loads.
- All remote-controlled model components function properly.
- All position indicators can be calibrated.
- Sufficient clearances are provided for differential deflections due to air loads.
- All leads are identified.
- All pressure lines are clean, free of oil and debris, and are leak-checked at operating pressures.
- All required inspections and certifications have been performed and documented (welds, concentricity, etc.).

5.5 Model Acceptance Criteria

Model Acceptance

Model acceptance for testing in the Wind Tunnel Operations Division facilities is contingent upon satisfaction of the requirements presented in section 5.2 through section 5.4, in addition to the requirements listed below.

Inspections

The customer must be prepared to provide inspection reports (records, inspection reports, and test results) for defining and verifying the quality of the model throughout all operations, including:

- Procurement
- Fabrication
- Test
- Delivery

The inspection report requirements are set by the Test Manager and will be provided for the customer at the Initial Test Planning Meeting. Typical reports required include the results of non-destructive weld examiniations and fastener/material certifications.

Structural Reports

The customer must provide:

- Any reports of inspections and tests of all materials by chemical or physical means to verify compliance with applicable drawings and specifications.
- Any written procedures, or other controls, over processes used to assure uniform quality of articles or materials..
- Documentation of all articles and materials that do not conform to applicable drawings, specifications, or other requirements.

Waivers

Requests for deviations from the requirements outlined in this document must be submitted in writing at the earliest possible time. The preferred time for waiver submission is at the Initial Test Planning Meeting. However, events in the model fabrication process may move the submittal of a waiver closer to the actual test time.

The Deviation Waiver request should include:

- Full justification for the waiver with supporting data and analysis.
- Previous test data of the same model in other facilities if applicable.

The following process is used for waiver approval:

- The Test Manager is responsible for the disposition of all submitted waiver requests.
- Waivers will be processed within four weeks of submittal to the Test Manager.
- The waiver will be analyzed and reviewed at a specially called Test Safety Review (A detailed explanation of Test Safety Reviews can be found in the Wind Tunnel Operations Division Test Process Manual.
- The customer will be apprised of the results of the Test Safety Review which will include acceptance, rejection, or required modifications to the waiver.

6.0 General Test Support Systems

Description

This section discusses these available test support systems:

- High-Pressure Air
- Hydraulic System
- Separation Support System
- Roll Adapter

6.1 High-Pressure Air

Description

High-pressure air (3,000 psi) is available at most of the Wind Tunnel Operations Division facilities.

In the 9x7ft, 11ft, and 12ft wind tunnels, a digital-valve system is installed for high-pressure air. Flow rates can be set in increments of 0.01 pounds per second and is repeatable to 0.02 pounds per second. An outlet pressure control mode is also available with a tolerance of ±2% of set point.

See section 7 for more details on the available mass flow for the other facilities.

Air Pumping and Storage Capacities

The pumping plant consists of three compressor systems having capacities of 8, 8, and 10 pounds per second, respectively, for a combined capacity of 26 pounds per second at 3,000 psi. The current storage capacity consists of 7.8 million standard cubic feet at 3,000 psi.

Air Heaters

Electric heaters (rated at 1.0 megawatt each) are available for heating high-pressure air. The heaters are made of four, equal-capacity resistive elements and are rated for 3,000 psi. The maximum heater outlet temperature is 400° F.

Low Air Heater Flows

The air heater controls may prohibit heater operation at very low air flows (below 0.5 lb/sec). For tests requiring low air flows or when preheated air lines are desired, it might be necessary to consult with a Test Manager for a particular facility.

Facilities Available for Heater Setup

Each of the following Wind Tunnel Operations Division facilities are set up for installation of heaters.

- 9x7ft Supersonic Wind Tunnel
- 11ft Transonic Wind Tunnel
- 12ft Pressure Wind Tunnel

Propulsion Simulator Calibration Laboratory

The Propulsion Simulator Calibration Laboratory has its own set of four banks of heaters that are rated at 225 kilowatts each. The maximum operating pressure is 3000 psi, and maximum output temperature is 400˚ F.

6.2 Hydraulic Systems

Portable Systems

Three portable hydraulic systems are available for use in any of theWind Tunnel Operations facilities. The supply capabilities of each system are as follows.

- 10.4 gallons per minute at 5,000 psi
- 10.7 gallons per minute at 3,000 psi
- 15.0 gallons per minute at 1,500 psi

Unitary Model Prep Rooms

The model preparation rooms in the Unitary Plan Wind Tunnels are equipped with permanent hydraulic systems capable of supplying 100 gallons per minute at 3,000 psi. All systems use MIL-H-5606 or DTE 25 oil.

6.3 Separation Support System

Angular Displacement

The system allows testing of two separating models. Angular displacement of the separation support system in the vertical and horizontal planes is provided by the respective wind tunnel support system. The separation support system provides displacement of the secondary model relative to the primary model.

Available Facilities

The manually controlled separation support system adapts to the tunnel strut system in the following facilities (also refer to section 7):

- 9x7ft Supersonic Wind Tunnel
- 11ft Transonic Wind Tunnel

Maximum Displacement Capability

The maximum displacement capability of the system is:

Axial displacement	9 inches
Horizontal displacement	10 inches
Vertical displacement	14 inches
Vertical angle displacement	±16 degrees
Lateral angle displacement	±6 degrees

Contact the Test Manager for any additional needs.

Load Limits

The load limits for both the primary and secondary models are 78,000 inch-pounds about the attachment of the stings to the separation support system.

6.4 Roll Adapters

Available Facilities

Two electrically driven, remotely controlled roll adapters are available for tests in the following facilities:

- 8x7ft Supersonic Wind Tunnel
- 9x7ft Supersonic Wind Tunnel
- 11ft Transonic Wind Tunnel

Availability and use of either of these adapters must be coordinated with the Test Manager.

The 12ft Pressure Wind Tunnel has its own roll mechanism system. See section 7.4.

Capacities

The roll adapters are 40 inches long and adapt to the primary strut support system in each of the above wind tunnels. The adapters are capable of 357 degrees of roll. The rolling moment is ±25,000 in-lbs.

The roll mechanism is capable of handling the loads and moments of the model support system. See section 7 for more information on individual model support systems.

7.0 Description of Test Facilities

Facilities

The facilities discussed herein are under the jurisdiction of the Wind Tunnel Operations Division of Ames Research Center. These facilities consist of three, closed-circuit, continuous-flow, wind tunnels.

Unitary Plan Wind Tunnels

The Unitary Plan Wind Tunnels are a set of three interconnected tunnels that share a central main drive system that can be used to drive either a transonic leg or a supersonic leg. The Unitary Plan Wind Tunnels are as follows.

- 11-by 11-Foot Transonic Wind Tunnel
- 9-by 7-Foot Supersonic Wind Tunnel

Other Tunnels

The other high speed wind tunnel facility is the 12-Foot Pressure Wind Tunnel.

7.1 11ft Transonic Wind Tunnel

Description

The 11-by 11-Foot Transonic Wind Tunnel is a closed-return, variable-density tunnel with a fixed-geometry, ventilated test section, and a dual-jack flexible nozzle.

The test section has 5.6 percent porosity consisting of evenly distributed slots on all four walls.

Air flow is produced by a three-stage, axial-flow compressor powered by four, wound-rotor, variable-speed, induction motors.

Operating Characteristics

The operating characteristics of the 11-by 11-Foot Transonic Wind Tunnel are presented in the following graph. The ranges of the pertinent performance characteristics are:

Mach number (continuously variable)	0.20 to 1.50
Stagnation pressure	3.0 to 32.0 psia
Reynolds number	0.3×10^6 to 9.6×10^6/ft
Maximum stagnation temperature	610°R
Strut angle of attack range	nominally ± 15°

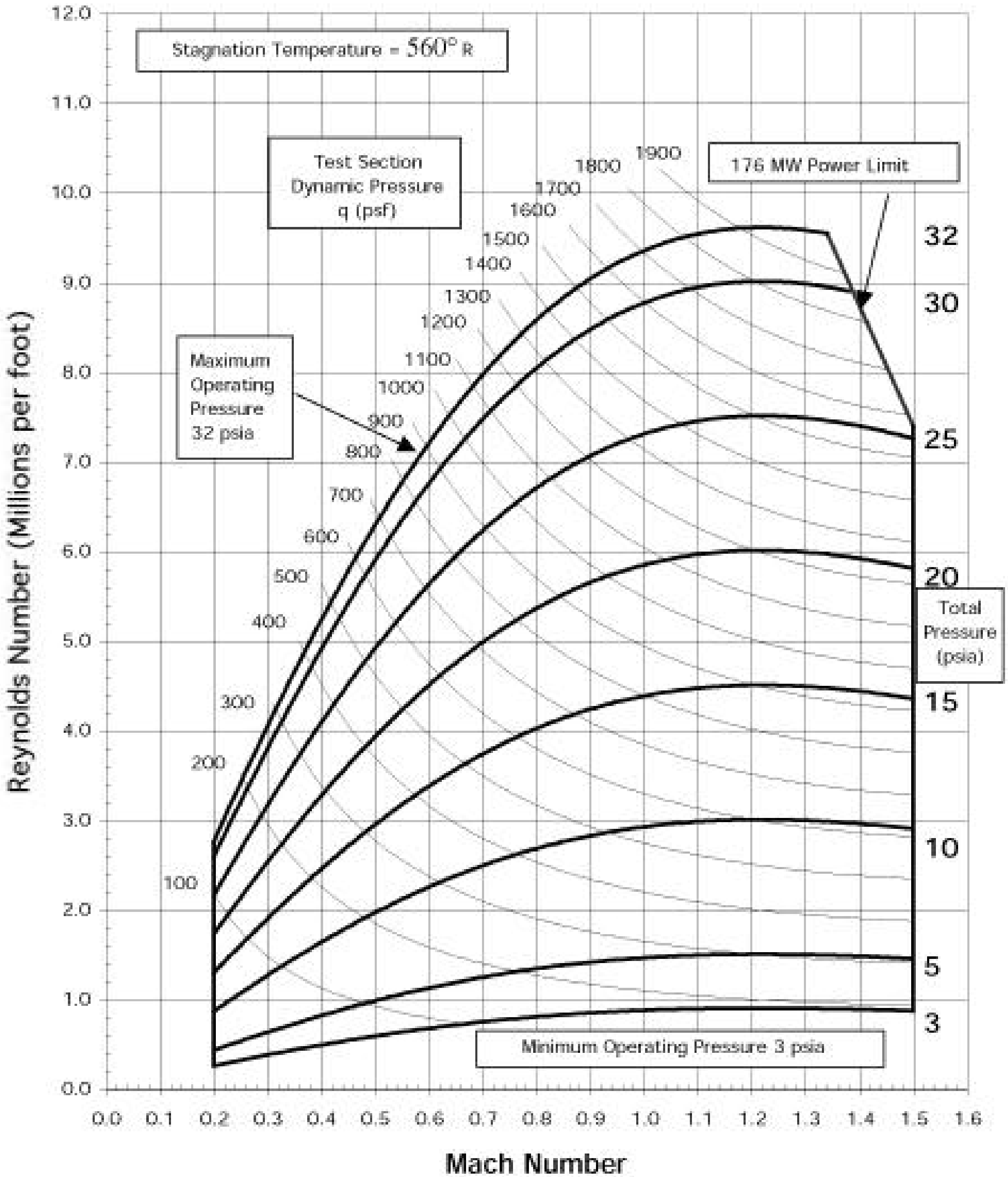


Figure 7-1: 11ft Transonic Wind Tunnel Operating Characteristics

Test Section Dimensions

Pertinent test section dimensions are:

Height	11.0 ft
Width	11.0 ft
Length	22.0 ft
Access hatch, top:	11.0 x 22.0 ft
Side doors:	3.0 x 4.9 ft

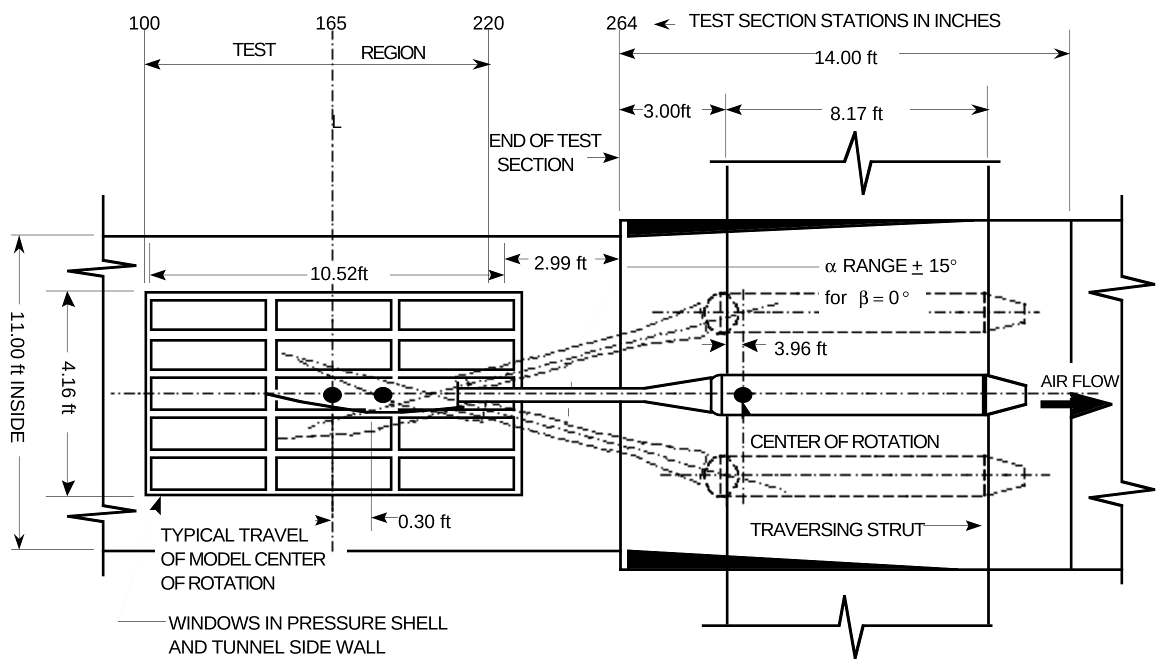
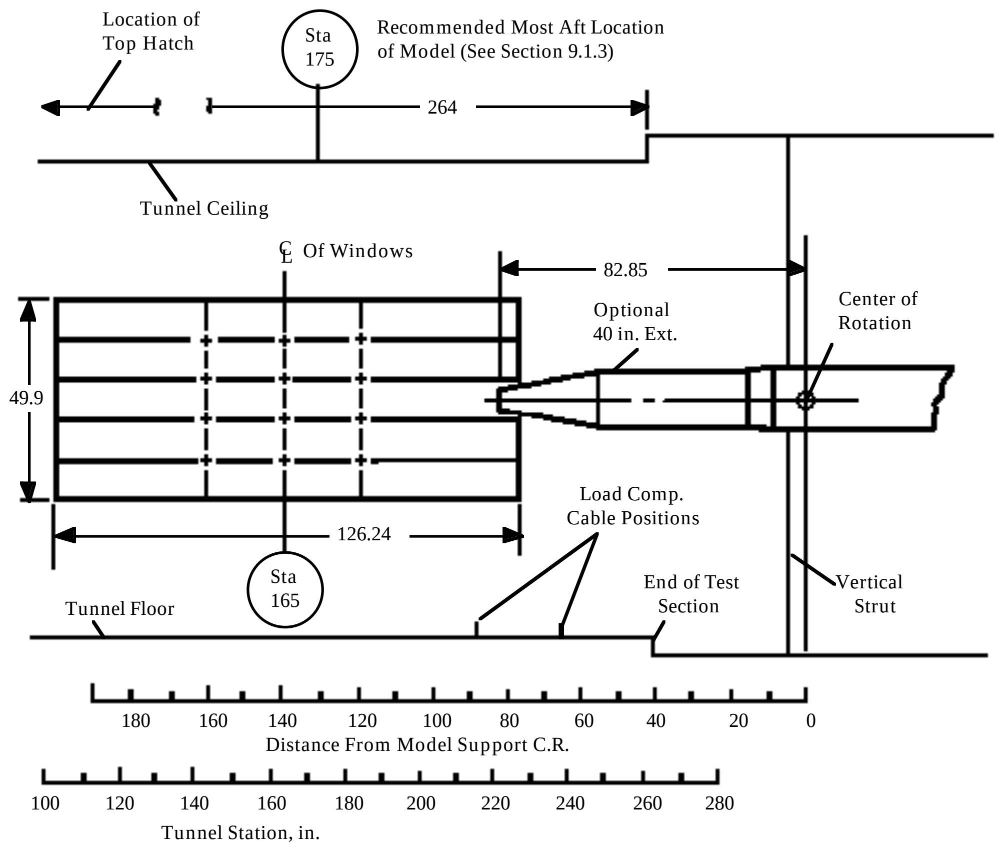


Figure 7-2: 11ft Transonic Wind Tunnel Test Section Dimensions

Model Installation Diagram

This diagram shows a sting installed with a 40-inch extension.



NOTE: All dimmensions are in inches

Figure 7-3: 11ft Transonic Wind Tunnel Sting Installation

Forward and Aft Limits

The forward and aft limits of the model location in the test section are dependent on the Mach number and the type of data required. As identified by tunnel station:

Table 7-1: 11ft Transonic Wind Tunnel Model Location Limits

Station	Limit
175	Aft limit for subsonic drag performance testing
193	Aft limit for subsonic static stability and control testing
220 60	Aft limit for supersonic static stability and control testing Forward limit for subsonic testing
100	Forward limit for supersonic testing

Consult the Test Manager for any deviations from these limits.

Forces and Moments

A traversing strut downstream of the test section can be programmed to translate vertically to maintain a desired point of model-pitch rotation throughout the vertical plane angle-range. The model support center-of-rotation in the horizontal plane is 4.8 inches aft of the strut leading edge. These angles are continuously variable and are determined by the relative positions of a knuckle and sleeve inside the support body.

The model support system can position the model at attitudes circumscribed by a 15-degree half-angle cone. Bent primary adapters of 5, 10, 12.5, and 20 degrees are available to alter the range of model angles. Forces and moments about the model support center of rotation are limited to:

Vertical	±8,000 lbs
Lateral	±4,000 lbs
Axial	±3,000 lbs
Rolling moment	±104,000 in-lbs
Combined vertical and lateral bending moment	±800,000 in-lbs

Load Compensation

A load compensation system capable of exerting a downward force of up to 8,000 lbs over a vertical travel range of 51 inches is available at tunnel stations 215.8 or 239.4. This system is used to offset high-lift forces which would otherwise exceed the design-load limits of the strut.

Turntable Model Support

A subfloor-mounted turntable model support, used primarily for semispan model testing, is located at tunnel station 106. This support system can be rotated ±180 degrees and forces and moments are limited to:

Lateral force (at a height of up to 24 inches above the floor):	±50,000 lbs
Torque (about axis of turntable):	±500,000 in-lbs

Semispan Testing

Provisions are available for sealing the slots in the test section floor to provide a solid image plane for semispan testing.

Installation and Personnel Access

Models can be installed through a hatch in the top of the test section. Personnel gain access to the test section through doors in the diffuser sidewalls downstream of the model support strut.

Flow Visualization

Flow visualization techniques are available through multiple, optical-quality windows in the tunnel sidewalls. Optical-quality windows are also available in the test section ceiling and floor.

High-Pressure Air

High-pressure air (3,000 psi) is available at weight flows to 80 pounds per second through dual, independently regulated lines ending within the support strut. A one-megawatt, moveable heater can preheat air from one of these lines. Preheated air at 60 pounds per second is available at the turntable.

7.2 9-by 7-Foot Supersonic Wind Tunnel

Description

The 9-by 7-Foot Supersonic Wind Tunnel is a closed-return, variable-density tunnel equipped with an asymmetric, sliding block nozzle.

The test section Mach number can be varied by translating, in the streamwise direction, the fixed contour block that forms the floor of the nozzle.

Airflow is produced by an 11-stage, axial-flow compressor powered by four variable-speed, wound-rotor, induction motors.

Operating Characteristics

Pertinent performance characteristics are:

Mach number (continuously variable)	1.54 to 2.56
Stagnation pressure	4.4 to 29.5 psia
Reynolds number	0.9×10^6 to 6.5×10^6/ft
Maximum stagnation temperature	600°R

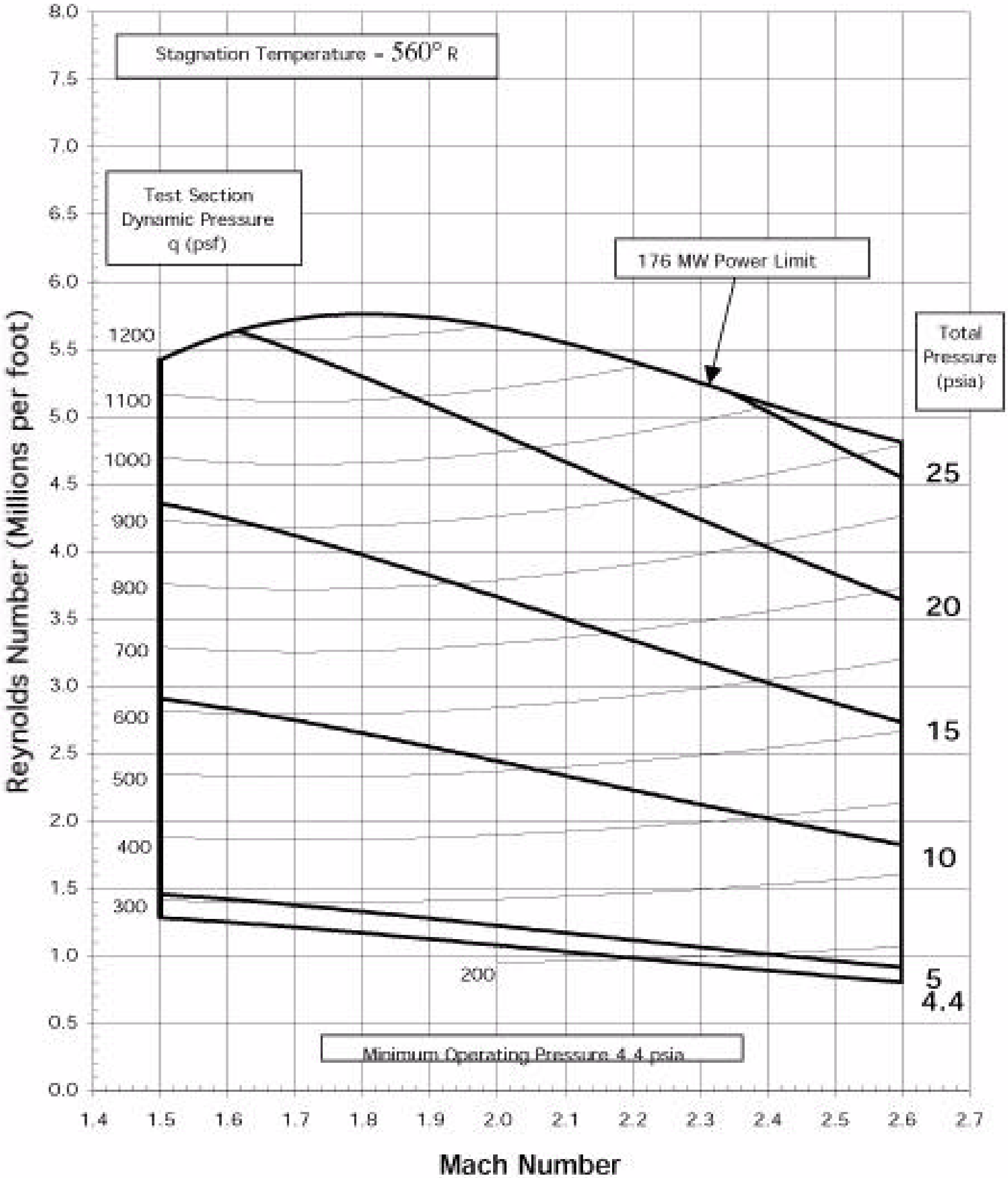
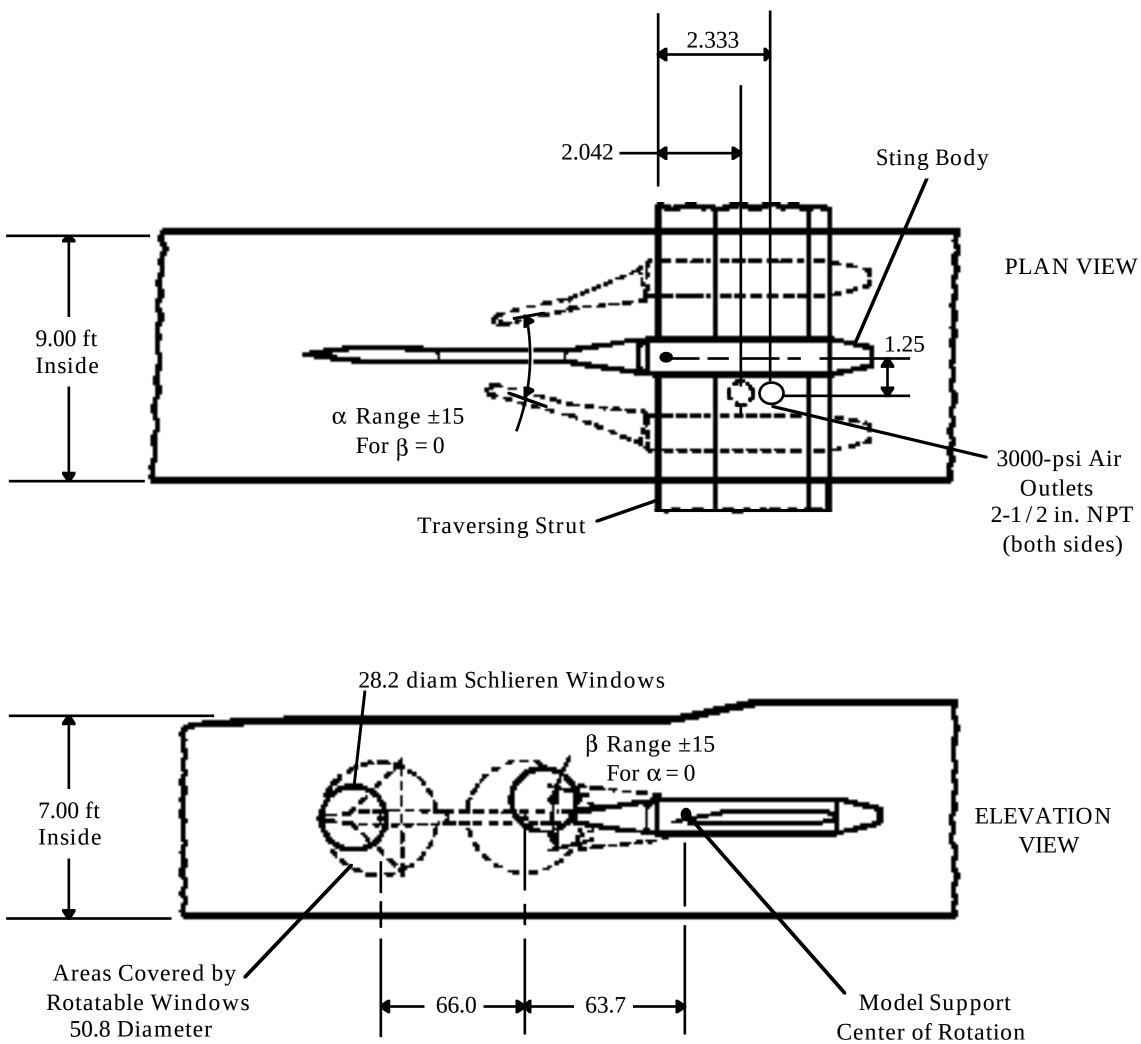


Figure 7-4: 9x7ft Supersonic Wind Tunnel Performance Characteristics

Test Section Dimensions

Pertinent test section dimensions are:

Height	7.0 ft
Width	9.0 ft
Length	18.0 ft
Access Hatches	
Removable Ceiling Panel:	6.0x9.0 ft
Side door:	3.0x6.5 ft



NOTE: All dimensions are in inches unless otherwise noted

Figure 7-5: 9x7ft Supersonic Wind Tunnel Test Section Dimensions

Model Installation Diagram

Model installation is normally accomplished through a 3x6.5-foot door in the north wall of the diffuser. Under special circumstances the model may be installed through the 6x9ft ceiling panel.

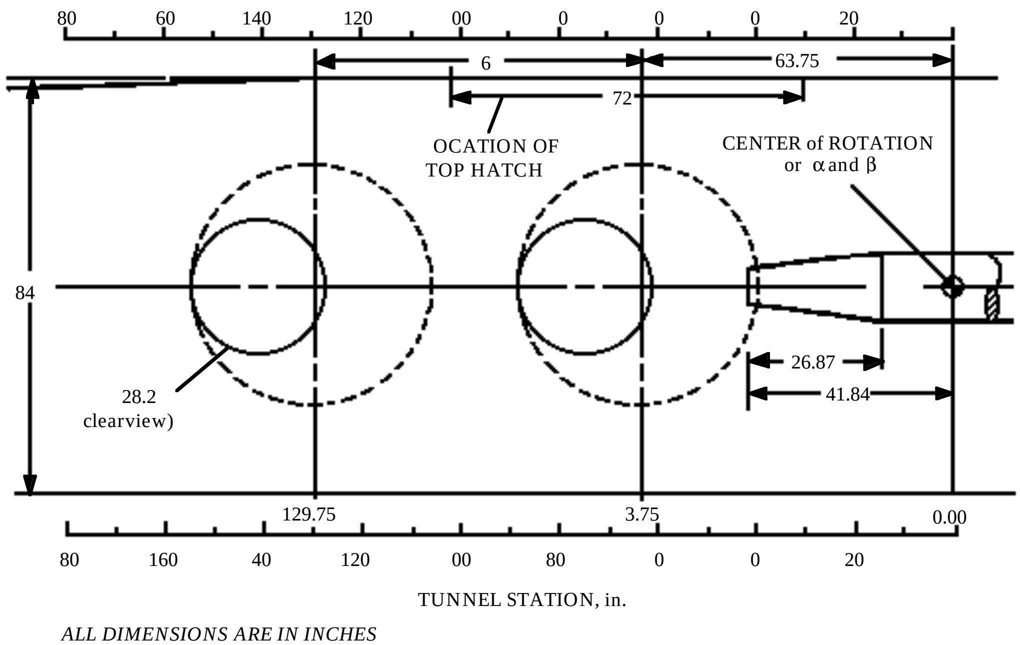


Figure 7-6: 9x7ft Supersonic Wind Tunnel Model Installation

Model Support System

A traversing strut downstream of the test section can be programmed to translate horizontally to maintain a desired point of rotation throughout the horizontal-plane angle-range, generally angle-of-attack.

The center of rotation in the vertical plane is 5.3 inches aft of the strut leading edge. The horizontal and vertical plane angles are continuously variable and are determined by the relative positions of a knuckle and sleeve inside the support body. The model support system can position the model at attitudes circumscribed by a 15-degree half-angle cone.

Bent primary adapters of 5, 10, 12.5, and 20 degrees are available to alter the range of model angles.

Forces and Moments

Forces and moments about the model support center of rotation are limited to:

Lateral	±8,000 lbs
Vertical	±4,000 lbs
Axial	±3,000 lbs
Rolling moment	±104,000 in-lbs
Combined vertical and lateral bending moment	±800,000 in-lbs

Flow Visualization

Schlieren and other flow visualization techniques can be obtained by appropriately positioning 2.35-foot diameter optical-quality windows in the test section sidewalls.

High-Pressure Air

High-pressure air (3,000 psi) is available at weight flows up to a total of 80 pounds per second through dual, independently regulated lines. Air from one of these lines can be preheated using a one megawatt moveable heater.

Reflected Shock Waves

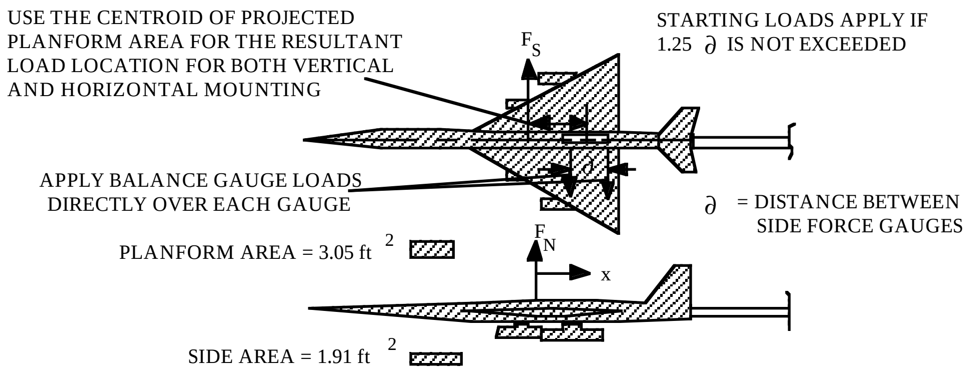
Shock waves reflecting on the model from the solid test section walls can have a significant effect on the model forces and pressures. To calculate the location of this reflected wave, assume it is reflected at the Mach angle from a 4-inch thick wall boundary layer.

Starting Loads

The design of models to be tested in the 9x7ft Supersonic Wind Tunnel must allow for additional critical conditions associated with blockage (the ratio of model-projected frontal area to test section cross-sectional area) and transient starting loads. Large model blockages provide a potential to “unstart” the airflow, allowing a strong shock wave to pass through the test section resulting in possible damage to the model, sting and balance.

Normal procedure is to reduce the tunnel pressure and position the model for minimum loads before beginning the acceleration to, or deceleration from, supersonic conditions.

However, significant transient loads are still generated by the swirling, subsonic, separated flows preceding the establishment of sonic velocity in the upstream throat. To ensure that a model, sting and balance will withstand these transients, they must be designed to withstand the empirically derived starting loads indicated in the following charts.



EXAMPLE 1. MODEL MOUNTED VERTICALLY	EXAMPLE 1. MODEL MOUNTED HORIZONTALLY
MODEL AND STING LOAD	MODEL AND STING LOAD
SIDE FORCE LOAD	SIDE FORCE LOAD
F_S = (300)(1.91) = 573 lb	F_S = (75)(11.91) = 143 lb
NORMAL FORCE LOAD,	NORMAL FORCE LOAD,
F_N = (175)(3.05) = 534 lb	F_N = (200)(3.05) = 610 lb
MOMENT, $M_x = \sqrt{F_S^2 + F_N^2}\ x = 783\ x$	MOMENT, $M_x = \sqrt{F_S^2 + F_N^2}\ x = 626\ x$
INDIVIDUAL BALANCE GAUGE LOAD	INDIVIDUAL BALANCE GAUGE LOAD
SIDE FORCE LOAD, EACH GAUGE,	SIDE FORCE LOAD, EACH GAUGE,
F_S = (375)(1.91) = 716 lb	F_S = (90)(1.91) = 172 lb
NORMAL FORCE LOAD, EACH GAUGE	NORMAL FORCE LOAD, EACH GAUGE,
F_N = (210)(3.05) = 641 lb	F_N = (280)(3.05) = 854 lb

Figure 7-7: 9x7ft Supersonic Wind Tunnel Load Locations

STARTING LOADS				
MODEL ORIENTATION	MODEL AND STING LOADS, lb / ft^2		INDIVIDUAL BALANCE GAUGE LOADS, lb / ft^2	
	WINGED MODELS	BODY ALONE	WINGED MODELS	BODY ALONE
VERTICAL PRIMARY LIFTING SURFACES:				
SIDE FORCE (VERTICAL DIRECTION)	300	200	375	200
NORMAL FORCE (HORIZONTAL DIRECTION)	175	150	210	150
HORIZONTAL PRIMARY LIFTING SURFACES:				
SIDE FORCE (HORIZONTAL DIRECTION)	75	150	90	150
NORMAL FORCE (VERTICAL DIRECTION)	200	200	280	200

Figure 7-8: 9x7ft Supersonic Wind Tunnel Starting Loads

7.3 12ft Pressure Wind Tunnel

Facility Description

The 12ft Pressure Wind Tunnel is a closed-return, variable-density, low-turbulence, subsonic wind tunnel.

Customers can test models on four different support systems with duplicates of these systems in two model preparation rooms to expedite model build-up, check-out, and installation.

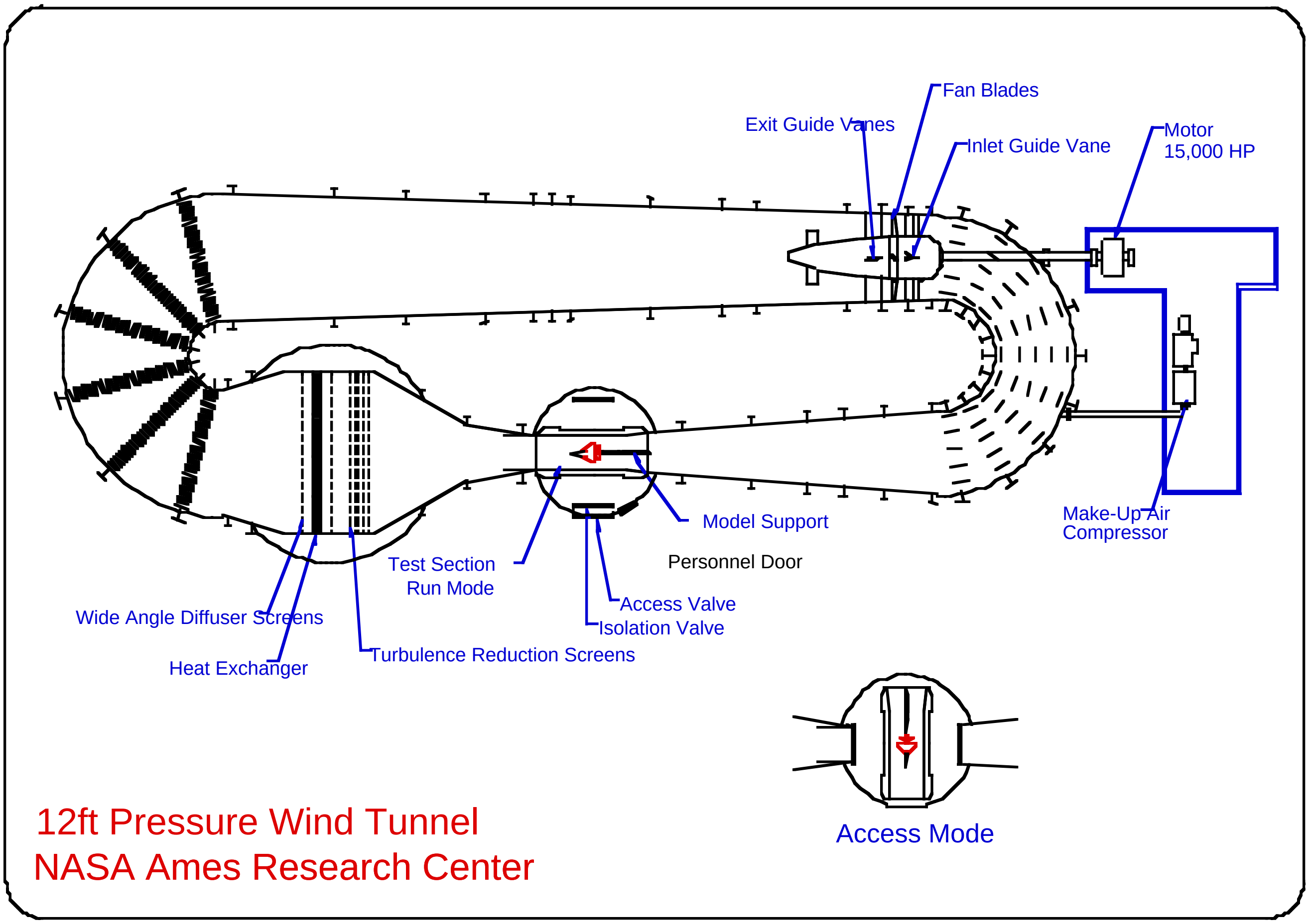


Figure 7-9: 12ft Pressure Wind Tunnel General Layout

Operating Characteristics

The ranges of pertinent performance characteristics are as follows.

Continuous Airspeed: Mach No. 0.05 to 0.55
Total Pressure: 0.2 to 6.0 atmospheres, absolute
Core Flow Quality (tunnel empty):
- Integrated flow angularity $\leq 0.02°$
- Longitudinal turbulence $\leq 0.05\%$
- Lateral turbulence $\leq 0.2\%$

Temperature variation less than 1°F across test section

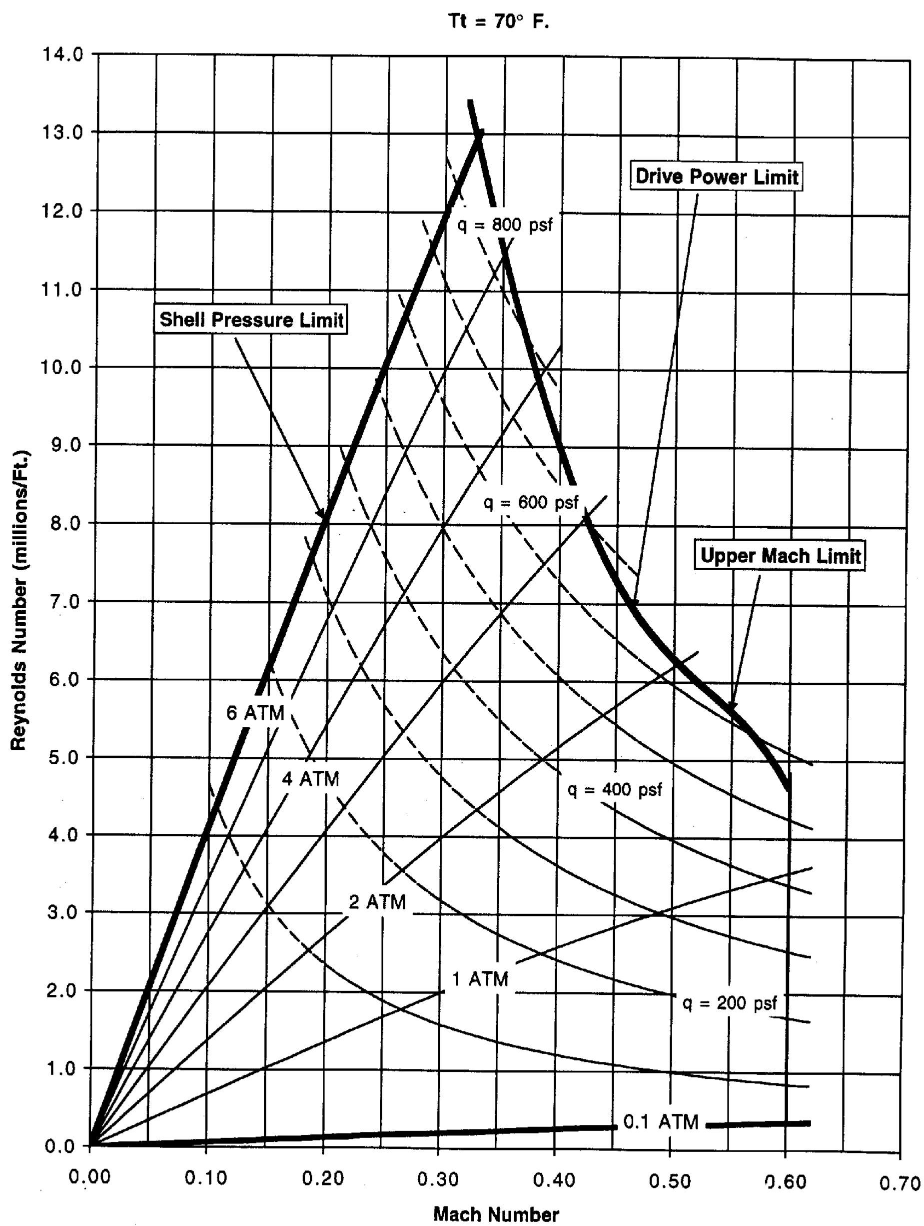


Figure 7-10: 12ft Pressure Wind Tunnel Operating Characteristics

Airflow Airflow is produced by a single-stage fan powered by a 15,000-hp, variable-speed synchronous motor with a solid-state, variable-frequency speed controller.

The single-stage main-drive fan has 20 fixed-pitch aluminum blades, 19 variable-camber inlet guide vanes with 50%-chord trailing edge flaps, and 15 fixed-camber exit guide vanes.

Settling Chamber

The settling chamber is designed to provide a very low-turbulence airstream. It contains a fin/tube heat exchanger (four tubes deep), one coarse-mesh screen (three 0.080" diameter wires per inch) and five fine-mesh screens (ten 0.020" diameter wires per inch). The area contraction ratio between the settling chamber and the test section is 21:1.

Test Section

The test section has a circular cross section with four 4-foot-wide flat surfaces centered about the horizontal and vertical centerlines. The width and height is 11.3 feet (between the flats), and the length is 28 feet.

Three 2x4ft optical-quality windows are available for wall and ceiling areas. Plastic (Lexan)or ultraviolet transparent acrylic windows or steel blanking plates are available for the remaining window spaces.

Test Section Isolation System

For efficient operation, the test section design permits access while the circuit is pressurized. The entire test section is mounted in a plenum on a carousel that rotates 90° about the vertical axis between the run and access positions.

While running, the test section is aligned with the tunnel circuit. When model access becomes necessary with the circuit pressurized, operators rotate the carousel 90°. The two circuit-to-plenum isolation valves are then locked in place and the plenum can be depressurized to atmosphere. Test section entry is through either the large plenum-access valve or the smaller personnel doors. It takes approximately 10 minutes to access the test section when the circuit is at 6 atmospheres.

Model Support Systems

Four model support systems are available:

Turntable Model Support (TRN)

The TRN is a variable-yaw support mounted in the floor of the test section. The TRN includes a lift platform for mounting the bipod (BMS) and a sector-type carriage and track for mounting the high angle- of-attack (HAA) strut. The TRN can also be adapted for semispan model testing.

Table 7-2: 12ft Pressure Wind Tunnel Turntable Design Characteristics

Operating Limits		Design Loads			
Yaw	+166.5° -191.4°	Normal (cross stream)	±40,000lbs	P. Mom. (about vertical axis)	±300,000 in-lbs
		Axial (streamwise)	±10,000lbs	R. Mom. (about horizontal axis)	±2,280,000 in-lbs

Bipod Model Support (BMS)

The BMS is a vertical pylon-type support mounted to the TRN lift platform. The BMS provides variable-pitch capability, which can be combined with the vertical-translation capability of the TRN lift platform and the variable-yaw capability of the TRN.

Table 7-3: 12ft Pressure Wind Tunnel Bipod Design Characteristics

Operating Limits		Design Loads			
Pitch	-15° to +45°	Normal	±12,000lbs	P. Mom.	±84,000 in-lbs
Yaw	+166.5° -191.4°	Axial	±3,000lbs	Y. Mom.	±42,000 in-lbs
Vertical	±20 in.	Side	±6,000lbs	R. Mom.	±30,000 in-lbs

High Angle of Attack (HAA)

The HAA model support is a variable pitch and roll system mounted to the TRN and uses the variable-yaw capability of the TRN. The pitch range is achieved in two steps: from -5° to 65° and from +25° to +95°. Roll changes are made at reduced wind speeds.

Table 7-4: 12ft Pressure Wind Tunnel High Angle Of Attack Design Characteristics

Operating Limits		Design Loads			
Pitch	-5° to +65° +25° to +95°	Normal	±6,000lbs	P. Mom.	±56,000 in-lbs
Yaw*	± 15°	Axial	±1,500lbs	Y. Mom.	±24,000 in-lbs
Roll	+185° -170°	Side	±3,500lbs	R. Mom.	±30,000 in-lbs

* Yaw limits vary depending on sting configuration.

Rear Sting Model Support (RSS)

The RSS mounts at the downstream end of the test section. It provides variable pitch, roll (with the optional roll pod), and heave (vertical translation) capabilities, with coordinated motions to achieve a variable virtual center of rotation. The RSS is not currently installed in the test section but can be made available based on test requirements.

Table 7-5: 12ft Pressure Wind Tunnel Rear Sting Design Characteristics

Operating Limits		Design Loads			
Pitch	-20° to +30°	Normal	±10,000lbs	P. Mom.	±70,000 in-lbs
Roll	+185° -170°	Axial	±5,000lbs	Y. Mom.	±30,000 in-lbs
Heave	±46 in	Side	±5,000lbs	R. Mom	±30,000 in-lbs

Control Room Features

The control room, located on the second floor, has workstations for the tunnel operator, test engineer, and data and instrument technicians.

The area also provides:

- interfacing equipment for the Standard Data System (SDS)
- space for customer personnel and equipment
- overhead cable trays, instrumentation power, shop air, and vacuum

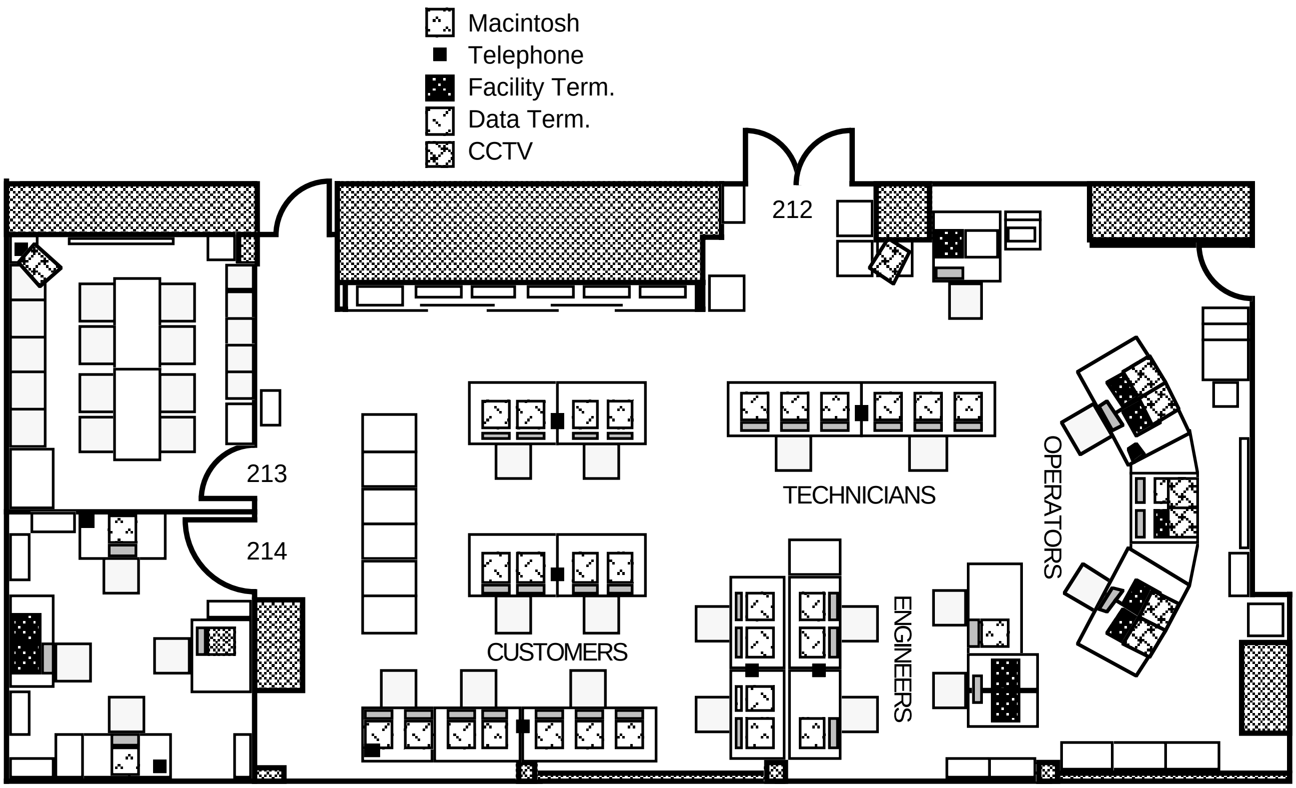


Figure 7-11: 12ft Pressure Wind Tunnel Control Room Layout

Tunnel Operating Modes

Various test parameters can be controlled independently or combined. The operating modes are as follows:

- MRT (Mach, Reynolds, Total Temperature)
- MPT (Mach, Total Pressure, Total Temperature) QRT (Dynamic Pressure, Reynolds, Total Temperature)
- QPT (Dynamic Pressure, Total Pressure, Total Temperature)
- VRT (Velocity, Reynolds, Total Temperature)
- VPT (Velocity, Total Pressure, Total Temperature)
- MQT (Mach, Dynamic Pressure, Total Temperature)
- MANUAL (Fan RPM and IGV flap setpoints entered)

Features of Model Preparation Rooms

The facility has two model preparation rooms. Model Preparation Room #1 is equipped with an RSS buildup fixture and a floor mount fixture. Model Preparation Room #2 has a floor mount fixture. The floor mount fixtures can accommodate models installed on either the HAA, bipod, or turntable model supports. Both rooms have floor-mounted anchor plates for mounting load application fixtures.

Each room provides:

- customer office space
- two-ton bridge crane
- SDS interface to verify instrumentation and programming
- shop air, instrument grade power, and building power

Located nearby are:

- machine shop for model parts modifications
- elevator for transporting models to the test section on the second- floor

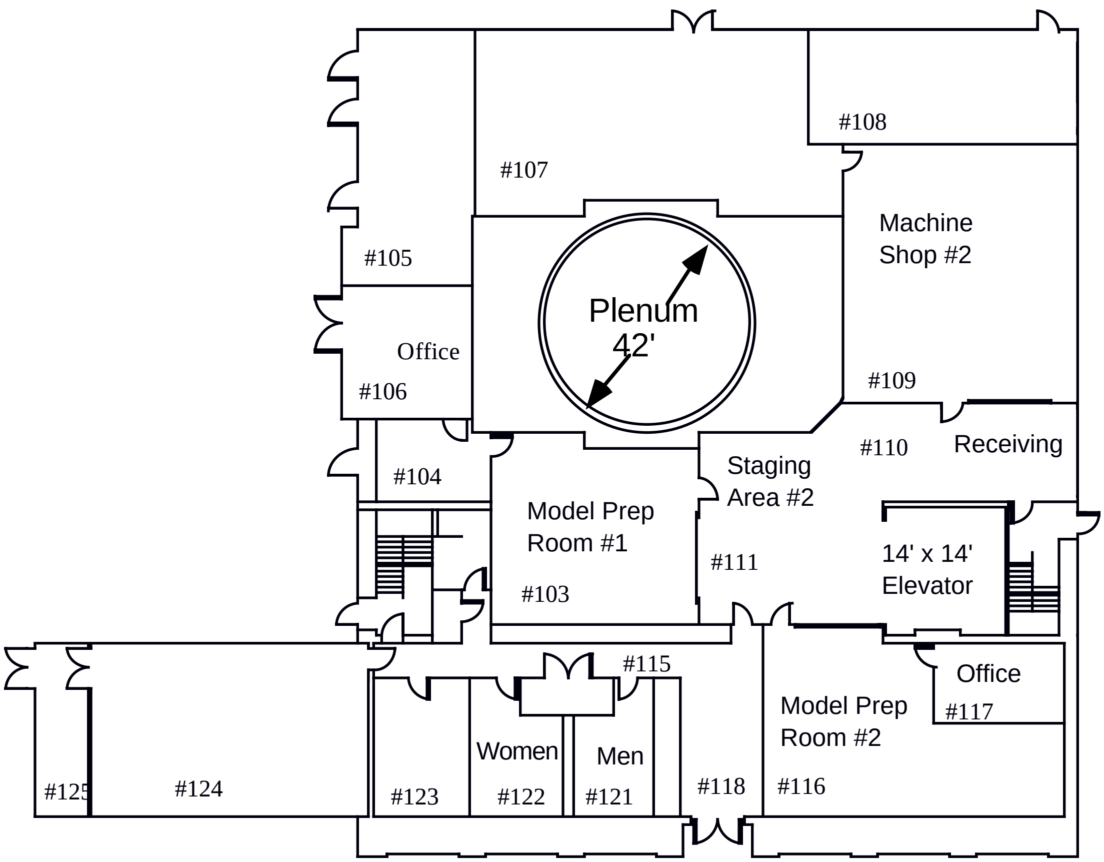


Figure 7-12: N206 First Floor Plan View

Appendix A Checking Taper Fits

Taper Fits

Wind tunnel models at Ames are supported by stings or wall-mounted assemblies that have mated, tapered joints. The contact between the male and female tapers must be accurate to assume full and even transfer of loads.

Customers who make tapers to mate with Ames' equipment can obtain the appropriate male or female taper gauge by contacting the Test Manager. Customers are responsible for fitting their taper to the gauge, and all customer-supplied taper joints, with not less than 80% contact area that is evenly distributed on the contacting surfaces.

The approved technique is to use fluorescent penetrant. Other techniques may be used, but please first submit procedures to and receive approval from the Test Manager.

Taper Fit Procedures

The procedures for performing taper fits are found in the Standard Operating Procedures for Sting Assembly and Storage Facility.

Customers may request a copy of these procedures from the Test Manager.

Appendix B List of Sting Hardware in Ames Inventory

Description

This appendix contains a list of model support (sting) hardware that Ames has available as of October, 1994.

Table Legend

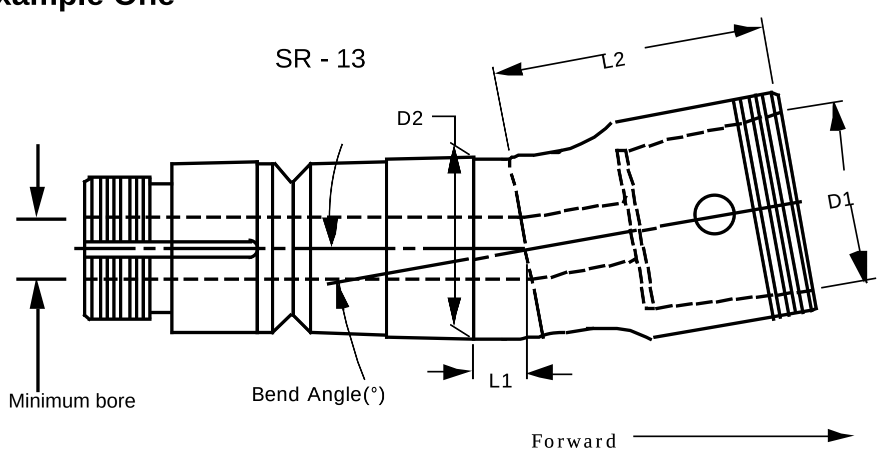
The sting hardware table legend is shown below.

SR #	Sting Assembly and Storage Facility Inventory Number
FTS	Front (upstream) Taper Size (inches)
FG	Front Taper Gender (M=male, F=female)
RTS	Rear (downstream) Taper Size (inches)
RG	Rear Taper Gender (M=male, F=female)
B_α	Bend Angle (degrees)
MB	Minimum Bore Diameter Through Sting (inches)
L1	Axis 1 Length (inches) Rear Taper <u>Not</u> Included
L2	Axis 2 Length (inches)
VO	Vertical Offset (inches)
W	Weight (pounds)
RC	Rockwell C Hardness

Examples

Hardware items in the following examples are identified by “sting room” number (SR #). The following examples illustrate properties for two types of hardware.

Example One —



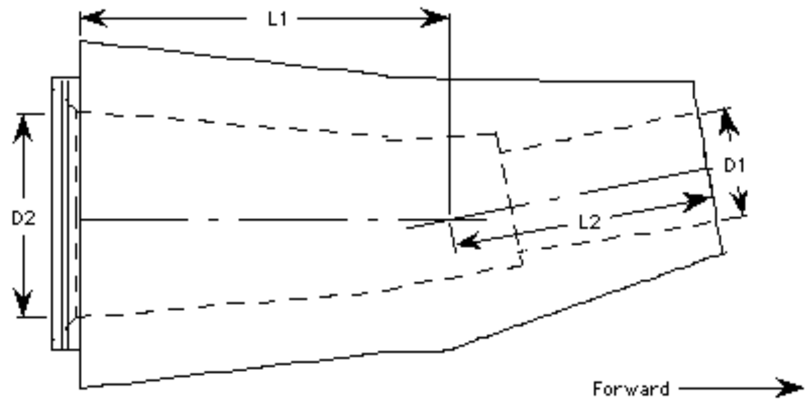
Adapter SR-13

Primary Adapter SR-13

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	Rc
13	4.5	F	Cornell 4.5"	4.5	M	Ames 4.5 Threaded, Push-on/off	10	1.5	1.364	6.78	0	50	45

Example Two—

SR - 42



Primary Adapter SR-42

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	Rc
42	4.5	F	Ames 4.5" Threaded	8.3	F	Ames 8.3" Standard	10	4	14.69	10.613	0	405	26

Sting Hardware Table

The table is divided into the following categories:

Adapters	Extensions
Extension/Adapters	Pivot Arms
Primary Adapters	Primary Adapter/Stings
Pylon Fittings	Roll Mechanism/Extensions
Stings	Sting/Adapters
Turnbuckle Arm	

Table B-1: Adapters

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_{α}	MB	L1	L2	VO	W	RC
1	2.75	F	?	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1.25	7.38	0	1.25	63	45
2	4.0	M		4.0	M		5	1.5	0	0	0	40	44
3	4.5	M	Ames 4.5" Push-on/off	4.5	M	Ames 4.5" Push-on/off	15	1.75	0	0	0	55	43
5	3.25	F	Task 4.0 Mk II, gauge# 300400	3.25	M	Task 4.0 Mk II, gauge# 300400	5	1.25	30.3	-20.2	0	52	45
6	3.0	F	Sleeve	4.5	M	Ames 4.5" Threaded	0	1.5	0	0	0	20	46
8	1.44	F	Task 2.0 gauge# 300300(300231)	3.25	M	Task 4.0 Mk II, gauge# 300400	0	1	10.75	6	0	25	33
11	4.5	F	Cornell 4.5"	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1.5	5.59	0	0	50	45
12	4.5	F	Cornell 4.5"	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1.25	6.38	5.25	0	65	44
13	4.5	F	Cornell 4.5"	4.5	M	Ames 4.5 Threaded, Push-on/off	10	1.5	1.364	6.78	0	50	45
18	4.5	M	Ames 4.5" Push-on/off	4.5	M	Ames 4.5" Push-on/off	5	1.75	0	0	0	55	40

Table B-1: Adapters

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
19	3.0	M	Langley	4.5	M	Ames 4.5" Push-on/off	0	1	18.5	0	0	55	35
20	3.25L	F	Task 4.0 Mk IV, gauge# 4626	4.5	F	Ames 4.5" Push-on/off	0	1.75	17.75	0	0	50	44
35		F	Press Fit Bolt On	4.5	M	Ames 4.5" Push-on/off	0	0	12.38	47.25	33.5	510	38
94	2.0L	F	Task 2.5 MkXX, gauge#3340, 2.5L	3.25	M	Task 4.0 Mk II, gauge# 300400	25	1.38	0.25	21	0	40	43
96	1.44	F	Task 2.0 gauge# 300300(300231)	2.0	M	Task 2.5 Mk III, gauge# 300373	49	0	7.32	13.81	0	25	41
106	3.25	F	Task 4.0 Mk II, gauge# 300400	3.25	M	Task 4.0 Mk II, gauge# 300400	13	0.68	7	0	0	30	43
126	2.875	F	Ames 2.875" Standard(6X6)			Bolt On	0	0	9	0	0	30	-11
127	4.5	F	Ames 4.5" Push-on/off	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	9	0	0	35	43
140	2.0	F	Task 2.5 Mk III, gauge# 300373			Bolt On	0	1.8	3.88	0	0	7	38
141	1.05	F	Task 1.5 Mk II, gauge# 300366			Bolt On	0	0.9	2.19	0	0	3	34
143	2.0	F	Task 2.5 Mk III, gauge# 300373	1.44	M	Task 2.0 gauge# 300300(300231)	0	0.44	3.25	0	0	3	37
145	2.0	F	Task 2.5 Mk III, gauge# 300373	2.0L	M	Task 2.5 MkXX, gauge#3340, 2.5L	0	0.63	4.25	0	0	5	39

Table B-1: Adapters

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
146	2.0	F	Task 2.5 Mk III, gauge# 300373	2.0L	M	Task 2.5 MkXX, gauge#3340, 2.5L	5	0.75	4	0	0	7	50
149	1.44	F	Task 2.0 gauge# 300300(300231)	2.0	M	Task 2.5 Mk III, gauge# 300373	55	0.5	0	0	0	12	36
150	1.44	F	Task 2.0 gauge# 300300(300231)	1.125	F	Fork	0	0.75	3.75	8.25	0	5	37
165.1	3.25L	F	Task 4.0 Mk IV, gauge# 4626			Bolt On	0	0	15.25	0	0	40	47
165.2	2.0	F	Task 2.5 Mk III, gauge# 300373			Bolt On	0	0	11.25	0	0	10	43
165.3			Bolt On			Bolt On	0	0	7.63	2.75	1	5	31
169.1	5.50	F	?	4.875	F	?	0	0	6	0	7	80	36
169.2	4.875	M	?	4.5	M	Ames 4.5 Threaded, Push-on/off	0	0	0	0	0	55	41
170	4.5	F	Ames 4.5" Push-on/off				0	4.1	9.75	0	0	50	47
171	5.0	F	?				0	0	24	0	0	125	31
174.9	1.00	F	Pinned			Bolt On	0	0	23.3	0	0	325	-12
183	2.875	F	Ames 2.875" Standard(6X6)			Bolt On	0	1.75	8.25	0	0	30	37
184	1.44	F	Task 2.0 gauge# 300300(300231)	2.0	M	Task 2.5 Mk III, gauge# 300373	0	0.63	3.88	0	0	10	42

Table B-1: Adapters

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
185	3.0	M	Boeing threaded/ pinned adapter	4.5	M Taper	Ames 4.5" Threaded	0	1.5	3.25	0	0	0	0
14	4.5	M	Ames 4.5" Push-on/off	4.5	M	Ames 4.5" Push-on/off	21	1.75	0	0	0	65	40

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Table B-2: Extensions

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
27	4.5	F	Ames 4.5" Push-on/off	4.5	M	Ames 4.5 Threaded, Push-on/off	0	2	30	10	0	275	39
28	4.5	F	Ames 4.5" Push-on/off	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1.5	27.3	10	0	270	36
29	4.5	F	Ames 4.5" Push-on/off	4.5	M	Ames 4.5 Threaded, Push-on/off	0	2	30	10	0	280	36
30	4.5	F	Ames 4.5" Push-on/off	4.5	M	Ames 4.5 Threaded, Push-on/off	0	2	30	10	0	280	44
34	4.5	F	Ames 4.5" Push-on/off	4.5	M	Ames 4.5" Threaded	0	1.5	22.5	10	0	160	46
64	4.5	F	Ames 4.5" Push-on/off	4.5	M	Ames 4.5 Threaded, Push-on/off	0	2	50	9.75	0	470	46
75	2.875	F	Ames 2.875" Standard(6X6)	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	30	0	0	100	30
159	8.3	M	Ames 8.3" Standard	8.3	F	Ames 8.3" Ringless	0	2	40.69	0	0	1640	34
163	8.3	M	Ames 8.3" Standard	8.3	F	Ames 8.3" Standard	0	2	20	0	0	730	41
167	2.875	F	Ames 2.875" Standard(6X6)	2.875	M	Ames 2.875" Standard(6X6)	0	1	64.7	0	0	210	-5
168	2.875	F	Ames 2.875" Standard(6X6)	2.875	M	Ames 2.875" Standard(6X6)	0	1	13.7	0	0	45	26
182	2.875	F	Ames 2.875" Standard(6X6)	2.875	M	Ames 2.875" Standard(6X6)	0	1	15.6	0	0	50	26

Table B-3: Extension/Adapter

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
4	2.875	F	Ames 2.875" Standard(6 X6)	4.5	M	Ames 4.5" Threaded	0	2	14.57	0	0	70	35
7	2.0	F	Task 2.5 Mk III, gauge# 300373	4.5	M	Ames 4.5" Threaded	0	1.5	15.38	0	0	75	42
9	4.0	F	Co-op gage H580	3.25 L	F		0	1.53	22.18	0	0	85	41
15	2.875	F	Ames 2.875" Standard(6 X6)	4.5	M	Ames 4.5 Threaded, Push-on/off	0	2	15.57	0	0	75	33
22	2.5	M	Langley	4.5	M	Ames 4.5" Threaded	0	0	23.5	0	0	170	39
23	2.875	F	Ames 2.875" Standard(6 X6)	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1.5	30.37	0	0	130	37
24	3.25	M	Langley	4.5	F	Ames 4.5" Threaded	0	1.12	16.81	0	0	190	40
33	2.875	F	Ames 2.875" Standard(6 X6)	4.5	M	Ames 4.5 Threaded, Push-on/off	0	2	30	0	0	130	33
63	2.875	F	Ames 2.875" Standard(6 X6)	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1.75	47.08	0	0	310	38
74	4.0	M Taper	Co-op gage H580	4.5	M	Ames 4.5 Threaded, Push-on/off	12	1.5	16.87	0	0	130	43

Table B-3: Extension/Adapter

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
80	2.875	F	Ames 2.875" Standard(6X6)	4.5	M	Ames 4.5" Threaded	0	1	28.38	0	0	110	35
153	1.05	F	Task 1.5 Mk II, gauge# 300366	2.875	M	Ames 2.875" Standard(6X6)	0	0.38	55.5	79	0	125	32
154	1.875	F	Sleeve	2.875	M	Ames 2.875" Standard(6X6)	45	0	0	0	0	80	31
155	4.0	F	Specific to the W1148 Parts Series	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1.5	27.39	0	0	145	42
158	2.875	F	Ames 2.875" Standard(6X6)	4.5	M	Ames 4.5" Threaded	0	2	14.38	0	0	70	34
44	4.5	F	Ames 4.5" Push-on/off	8.3	F	Ames 8.3" Standard	0	1.75	46.38	0	0	570	31

Table B-4: Pivot Arms

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
164.3	4.5	F	Ames 4.5 Threaded, Push-on/off	1.5	F	Pinned	0	4.1	8.25	9	0	60	36
174.1			Pinned			Bolt On	0	0	9.25	7.75	0	40	44
174.2			Bolt On			Pivot Arm Sting	0	0	22.75	0	0	45	44
174.3			Bolt On			Pivot Arm Sting	0	0	22.75	0	0	55	41

Table B-4: Pivot Arms

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_{α}	MB	L1	L2	VO	W	RC
174.4	2.0	F	Task 2.5 Mk III, gauge# 300373			Pivot Arm Sting	0	0	27.5	0	0	45	34
174.7	2.0	F	Task 2.5 Mk III, gauge# 300373			Pivot Arm Sting	0	0	44.5	0	0	75	35
174.8	2.875	F	Ames 2.875" Standard(6 X6)			Pivot Arm Sting	0	0	0	0	0	45	39

Table B-5: Primary Adapters

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_{α}	MB	L1	L2	VO	W	RC
36	4.5	F	Ames 4.5" Threaded	8.3	F	Ames 8.3" Standard	0	4.5	25.38	0	0	370	26
37	4.5	F	Ames 4.5" Threaded	8.3	F	Ames 8.3" Standard	10	4	14.69	10.61	0	405	23
38	4.5	F	Ames 4.5" Threaded	8.3	F	Ames 8.3" Standard	0	4.38	25.38	0	0	360	35
40	4.5	F	Ames 4.5" Threaded	8.3	F	Ames 8.3" Standard	20	4.1	15.81	10.61	0	400	32
41	4.5	F	Ames 4.5" Threaded	8.3	F	Ames 8.3" Standard	12.5	4	14.69	9.90	0	405	32
42	4.5	F	Ames 4.5" Threaded	8.3	F	Ames 8.3" Standard	10	4	14.69	10.613	0	405	26
43	4.5	F	Ames 4.5" Threaded	8.3	F	Ames 8.3" Standard	0	4.38	25.38	0	0	370	27
45	6.9	F	Grumman 6.9"	8.3	F	Ames 8.3" Standard	5	6	26	0	0	360	11
46	4.5	F	Ames 4.5" Threaded	8.3	F	Ames 8.3" Standard	5	4	14.69	10	0	375	38
47	4.5	F	Ames 4.5" Threaded	8.3	F	Ames 8.3" Standard	0	4	25.38	0	0	375	35
48	4.5	F	Ames 4.5" Threaded	8.3	F	Ames 8.3" Standard	0	4.1	25.38	0	0	380	28
49			Bolt-On	8.3	F	Ames 8.3" Standard	0	2	47.73	26.22	0	755	47
161			Northrop Model 403	8.3	F	Ames 8.3" Standard	0	4	55.21	0	0	1880	33

Table B-5: Primary Adapters

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_{α}	MB	L1	L2	VO	W	RC
162	6.0	M	Langley	8.3	F	Ames 8.3" Standard	0	0	38.5	0	0	870	44
164		F	Fork	8.3	F	Ames 8.3" Standard	0	2	38	0	0	410	24
175	9.2	M	Clamp	8.3	F	Ames 8.3" Standard	0	7.2	17.88	0	0	295	34
59	2.875	F	Ames 2.875" Standard(6X6)	8.3	F	Ames 8.3" Standard	0	1.5	59	0	0	900	29

Table B-6: Primary Adapter/Stings

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_{α}	MB	L1	L2	VO	W	RC
50	3.25L	F	Task 4.0 Mk IV, gauge# 4626	8.3	F	Ames 8.3" Standard	0	2	111.6	0	0	885	27
51	3.25	F	Task 4.0 Mk II, gauge# 300400	8.3	F	Ames 8.3" Standard	0	2	115.6	0	0	890	33
52	3.25L	F	Task Mk IVA 4.0 Bal	8.3	F		0	2	89.5	0	10	905	33
53	4.0	F	Task 4.0 Mk IV, gauge# 4626	8.3	F	Ames 8.3" Standard	12	2	48.8	67.519	0	0	0
57	4.5	F	Ames 4.5" Push-on/off	8.3	F	Ames 8.3" Standard	0	1.75	66.38	0	0	665	44

Table B-7: Pylon Fittings

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_{α}	MB	L1	L2	VO	W	RC
164.1			Pinned			Bolt On	0	0	8.25	0	0	70	12
164.2			Pinned			Bolt On	0	0	11.38	0	0	70	34

Table B-8: Roll Mechanism/Extensions

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_{α}	MB	L1	L2	VO	W	RC
21	1.625	Square	Unknown	2.875	M	Ames 2.875" Standard(6X6)	0	0	34	0	0	210	21
188	8.3	M	Ames 8.3" Standard	8.3	F	Ames 8.3" Standard	0	0	40	0	0	1380	0
189	8.3	M	Ames 8.3" Standard	8.3	F	Ames 8.3" Standard	0	0	40	0	0	1410	0

Table B-9: Stings

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_{α}	MB	L1	L2	VO	W	RC
25	2.5	F	Sliding fit w/ D111-2	4.5	M Taper	Ames 4.5" Threaded	13	2	9.88	19.25	0	85	26
26	3.25 L	F	Task 4.0 Mk IV, gauge# 4626	4.5	M	Ames 4.5 Threaded, Push-on/off	15	1.38	0	30.38	0	130	43
31	1.25	F	Fork	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1	35.75	0	0	270	45
54	2.5	M	Langley	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1.5	69.75	0	0	365	43

Table B-9: Stings

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
55	2.0	F	Task 2.5 MkXX, gauge#3340 , 2.5L	4.5	M	Ames 4.5" Threaded	0	1.25	73.38	0	0	240	53
56	1.44	F	Task 2.0 gauge# 300300(300231)	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1.25	76.75	0	0	185	51
61	2.25	M	Balance outer sleeve dimensions	4.5	M	Ames 4.5" Threaded	0	1	59.5	10	0	170	37
62	3.25	F	Task 4.0 Mk II, gauge# 300400	4.5	M	Ames 4.5" Threaded	0	2	61.25	0	0	235	33
68	2.0	F	Task 2.5 MkXX, gauge#3340 , 2.5L	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1	54.41	0	0	155	46
70	2.0	F	Task 2.5 MkXX, gauge#3340 , 2.5L	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1	51	0	0	150	51
72	2.0	F	Task 2.5 MkXX, gauge#3340 , 2.5L	4.5	M	Ames 4.5" Threaded	0	0.83	58	0	0	210	49
76	2.5L	F	Task 2.5 MkXX, gauge#3340 , 2.5L	4.5	M	Ames 4.5" Push-on/off	15	1	13	24	0	90	45
79	2.0	F	Task 2.5 Mk III, gauge# 300373	4.5	M	Ames 4.5" Threaded	0	0.75	66.37	0	0	230	35
83	.9375	F	?	2.875	M	Ames 2.875" Standard(6X6)	0	0.38	38.84	0	0	35	43
84	1.05	F	Task 1.5 Mk II, gauge# 300366	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	34	0	0	40	51

Table B-9: Stings

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
85	.75	F	Task 1.0 MkVI & XIV, gauge#6674	2.875	M	Ames 2.875" Standard(6X6)	0	1	40.75	0	0	30	53
86	1.44	F	Task 2.0 gauge# 300300(300231)	2.875	M	Ames 2.875" Standard(6X6)	0	0.781	32.59	0	0	40	35
87	1.44	F	Task 2.0 gauge# 300300(300231)	2.875	M	Ames 2.875" Standard(6X6)	0	1	38.9	0	0	40	26
88	1.44	F	?	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	35.5	0	0	50	36
89	1.05	F		2.875	M	Ames 2.875" Standard(6X6)	0	0.75	39.38	0	0	40	44
90	2.0	F	Task 2.5 Mk III, gauge# 300373	2.875	M	Ames 2.875" Standard(6X6)	0	0.79	17.88	0	0	30	35
91	2.0	F	Task 2.5 Mk III, gauge# 300373	2.875	M	Ames 2.875" Standard(6X6)	0	0.781	17.75	0	0	30	33
92	1.5	M	Balance outer sleeve dimensions	2.875	M	Ames 2.875" Standard(6X6)	0	1.25	23.25	0	0	20	40
93	.75	F	Task 1.0 MkVI & XIV, gauge#6674	2.875	M	Ames 2.875" Standard(6X6)	0	1	23.13	0	0	20	44
97.2	1.75	F	Fork	2.0	M	Pivot Arm Sting	0	0.75	24	1	0	80	36
97.3	1.05	F	Task 1.5 Mk II, gauge# 300366	1.75	M	Pivot Arm Sting	0	0.75	15.5	1	0	10	34
101	1.30	F	Task 1.75 Mk I, gauge# 10191	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	12.5	0	0	20	32

Table B-9: Stings

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_{α}	MB	L1	L2	VO	W	RC
107	2.0	F		2.875	M	Ames 2.875" Standard(6X6)	0	1	37.63	0	0	45	44
108	2.0	F	Task 2.5 Mk III, gauge# 300373	2.875	M	Ames 2.875" Standard(6X6)	5	0.78	37.69	0	0	70	28
109	2.0	F	Task 2.5 Mk III, gauge# 300373	2.875	M	Ames 2.875" Standard(6X6)	0	0.78	37.69	0	0	55	19
110	1.44	F	Task 2.0 gauge# 300300(300231)	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	33	0	0	45	54
111	2.0	F	Task 2.5 Mk III, gauge# 300373	2.875	M	Ames 2.875" Standard(6X6)	5	0.78	33.25	0	0	0	20
112	2.0	F	Task 2.5 Mk III, gauge# 300373	2.875	M	Ames 2.875" Standard(6X6)	0	1	37.69	0	0	60	29
113	2.0	F	Task 2.5 Mk III, gauge# 300373	3.25	M	Task 4.0 Mk II, gauge# 300400	0	0.75	21	0	0	60	44
114	1.44	F	Task 2.0 gauge# 300300(300231)	2.875	M	Ames 2.875" Standard(6X6)	15	1	14.75	13	0	55	32
115	1.05	F	Task 1.5 Mk II, gauge# 300366	2.875	M	Ames 2.875" Standard(6X6)	0	0	22.5	0	8	40	43
116			?	2.875	M	Ames 2.875" Standard(6X6)	0	0	23.5	0	0	55	11
117	2.0	F	Task 2.5 Mk III, gauge# 300373	3.25	M	Task 4.0 Mk II, gauge# 300400	36	1.38	0.65	17.5	0	35	44
118	1.44	F	Task 2.0 gauge# 300300(300231)	2.875	M	Ames 2.875" Standard(6X6)	0	0.78	32.59	0	0	40	33

Table B-9: Stings

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
119	1.44	F	Task 2.0 gauge# 300300(300231)	2.875	M	Ames 2.875" Standard(6X6)	4	0.75	13.1	3.2	0	20	38
123	.613	F		1.44	M	Task 2.0 gauge# 300300(300231)	0	0.38	0	0	0	5	40
124	1.05	F	Task 1.5 Mk II, gauge# 300366	2.0	M	Task 2.5 Mk III, gauge# 300373	0	0.38	16.63	0	0	15	40
125	2.0	F	Task 2.0 gauge# 300300(300231)			2 LAND SLEEVE	0	0	0	0	0	15	32
128	2.0	F	Task 2.5 Mk III, gauge# 300373	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	32.63	0	0	60	35
129	1.05	F	Task 1.5 Mk II, gauge# 300366	2.875	M	Ames 2.875" Standard(6X6)	0	0.78	37.69	0	0	40	26
130	1.44	F	Task 2.0 gauge# 300300(300231)	2.875	M	Ames 2.875" Standard(6X6)	0	0.78	36.88	0	0	45	35
131	1.05	F	Task 1.5 Mk II, gauge# 300366	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	37.75	0	0	40	37
132	1.44	F	Task 2.0 gauge# 300300(300231)	2.875	M	Ames 2.875" Standard(6X6)	0	0.78	32.59	0	0	30	37
133	.938	F	?	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	0	0	0	35	41
134	1.44	F	Task 2.0 gauge# 300300(300231)	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	32	0	10	65	38

Table B-9: Stings

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_{α}	MB	L1	L2	VO	W	RC
135	1.05	F	Task 1.5 Mk II, gauge# 300366	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	37.75	0	0	30	41
136	1.05	F	Task 1.5 Mk II, gauge# 300366	2.875	M	Ames 2.875" Standard(6X6)	30	0.75	0	0	0	30	36
137	1.0	F	Task 1.5 Mk II, gauge# 300366	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	37.75	0	0	35	40
138	1.44	F	Task 2.0 gauge# 300300(300231)	2.875	M	Ames 2.875" Standard(6X6)	0	0.78	32.63	0	0	40	30
139	1.05	F	Task 1.5 Mk II, gauge# 300366	2.875	M	Ames 2.875" Standard(6X6)	0	0.38	34.63	0	0	30	43
144	1.44	F	Task 2.0 gauge# 300300(300231)	1.44	M	Task 2.0 gauge# 300300(300231)	6	0.5	0	0	0	3	38
151	2.0	F	Task 2.5 MkXX, gauge#3340, 2.5L	4.5	M	Cornell 4.5"	0	0.75	42.78	0	0	100	46
152	1.44	F	Task 2.0 gauge# 300300(300231)	4.5	M	Cornell 4.5"	0	0.75	43	2.56	0	120	40
157	2.0L	F	Task 2.5 MkXX, gauge#3340, 2.5L	4.5	M	Ames 4.5" Push-on/off	0	1	39.75	0	3	140	0
160	3.25	F	Task 4.0 Mk II, gauge# 300400	4.5	M	Ames 4.5 Threaded, Push-on/off	0	2	29	0	0	105	38
165			Bolt On	4.5	M	Ames 4.5 Threaded, Push-on/off	0	0	98	0	0	545	43

Table B-9: Stings

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
166	3.25	F	Task 4.0 Mk II, gauge# 300400	6.9	M	Grumman 303	0	0	93	0	0	640	41
169			Bolt On	5.50	M	?	0	0	75	0	0	275	41
172	2.0	F	Task 2.5 MkXX, gauge#3340, 2.5L	4.5	M	Ames 4.5 Threaded, Push-on/off	0	1.25	66.38	0	0	255	41
173			Balance outer sleeve dimensions			Pivot Arm Sting	0	0	0	0	0	510	46
176	1.44	F	Task 2.0 gauge# 300300(300231)	4.5	M	Cornell 4.5"	0	0.75	44.5	2.56	0	120	46
178	3.25	F	Task 4.0 Mk II, gauge# 300400	4.5	M	Cornell 4.5"	0	1	40.75	0	0	165	47
181	2.0	F	Task 2.5 Mk III, gauge# 300373	2.875	M	Ames 2.875" Standard(6X6)	0	0.785	36	0	0	55	39
186		F Socket	0		F Socket		0	1	50.21	0	0	0	0
187	2.0	F	Task 2.5 Mk III, gauge# 300373	2.875	M	Ames 2.875" Standard(6X6)	0	0.78	40.41	0	0	0	0

Table B-10: Sting/Adapters

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
69	1.44	F	Task 2.0 gauge# 300300(300231)	3.25	F	Langley?	0	0.75	62.25	0	0	105	41

Table B-10: Sting/Adapters

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
71	3.0	F	?	4.5	M	Ames 4.5" Threaded	0	2	47.13	0	0	215	40
97.1	2.0	F	Fork	2.875	M	Ames 2.875" Standard(6X6)	0	0.75	6	1	0	30	36
174	1.375	F	Pivot Arm Sting	4.5	M	Ames 4.5 Threaded, Push-on/off	0	0	33	0	0	230	38
174.5	1.313	F	?			Bolt On	0	0	15.63	0	0	10	33
174.6	1.375	F	?			Bolt On	0	0	15	0	0	20	44
177			?	4.5	M	Cornell 4.5"	0	0	45.75	0	0	165	41

,

Table B-11: Turnbuckle Arm

SR #	FTS	FG	Front Taper Type	RTS	RG	Rear Taper Type	B_α	MB	L1	L2	VO	W	RC
164.4	1.00	F	Pinned	1.00	F	Pinned	0	0	52	0	0	60	19

Appendix C Summary of Customer Actions and Deliverables

C.1 General Checklist

Description The following table is a checklist of items expected from customers in the time frames shown.

Table C-1: Customer Supplied Items Checklist

Item	Recommended. no. of weeks prior to test
Test Justification Meeting	26
Initial Test Planning Meeting	12
Test Objective Document	13
Request for use of general support systems contained in Section 6.0	8
Request for use of instrumentation items contained in Appendix D.	8
Data-plotting requests	8
Drawings of model support systems and installations	6
Customer data-reduction equations	6
Customer balance if calibration required	6
Customer-supplied model support hardware (stings)	6
Stress report	6
Model assembly, installation, and change procedures	6
Model cross-sectional area distribution	4
Finalized run schedule	4
Details of Customer-furnished equipment	4
Customer-supplied constants for the data-reduction program	4
Customer-supplied calibrations	4
MSDS sheets for all Customer-supplied chemicals	4
Personnel arrival information	See sec. 3
Model and support equipment	1

C.2 Test Request Form

Description

This form is filled out by the customer to inform the Wind Tunnel and Aerodynamics group of the services needed. A blank form is shown in Figure C-1. This form may be copied for use by a Customer. It is also available electronically on Microsoft® Word.

TEST REQUEST FORM

Test Title:

Requestor Information:
Organization:
Contact: *(Include name and title)*
Address:
Telephone: Voice: Fax:
E-mail:

Sponsor Information:
Organization: *(Principle sponsor such as NASA, DoD, Air Force, Navy, Company, etc.)*
Contact: *(Include name and titled*
Address:
Telephone: Voice: Fax:
E-mail:

Other Organizations Supporting the Test: *(Secondary organizations that will be supporting the test and what that support is: staffing, money, equipment, etc. For example provide company name, number of researchers, number of test managers, and number of model technicians)*

Program Affiliation:
Program Office:
Airframe Systems
Civil Transports
High Performance Aircraft
Fundamental Concepts & Methods
Other____________________________
High Speed Research
Advanced Subsonic Technology
Rotorcraft
Space Transportation

Schedule:
Requested Test Section Occupancy Entry Date (M/D/Y)
Estimated (Test section occupancy hours)
Earliest date model can be delivered to facility (M/D/Y)
Latest date for test completion (M/DN)

Facility Preference (if known)

General Description of the Test:

Figure C-1: Test Request Form (Sheet 1 of 3)

Specific Test Objectives:

Model/Test Hardware:
Designation: Scale:
Description:
Size (key dimensions such as, wing area, span, length, blockage area, weight, etc. Minimum possible scale should also be included):

Current Status: Concept definition Design Fabrication Ready for test
Previously Tested
Where tested____________________________
When tested_____________________________

Type of Test (Circle all that apply):

Aircraft/missile performance	Inlet
Aircraft/missile stability and control	2-D Airfoil
Rotorcraft	STOVL
Forced oscillation	Ground Effects
Free flight	Acoustic
Propulsion	
Burning propulsion system	Propulsion/airframe integr. test
Nozzle test	
HGI	
Fuels required (please list)	
Other test type -describe:	

Model/Configuration Changes:
Total number of changes_______________________
Percent - Remove and reinstall model________________________
Percent - Major model component change________________________
Percent - Control surface change__________________________
Estimate of average time required to make changes if known
Remove and reinstall model______________________
Major model component change_______________________
Control surface change______________________________
Indicate time required for any changes that are significantly longer than the average.

Figure C-1: Test Request Form (Sheet 2 of 3)

Type of Data Required:

Force and moment — No. of data points____________

Strain gauge

Pressures (ESP) Approx. No. of orifices — No. of data points____________

Model Deformation

Dynamic — No. of data points____________

Pressure sensitive paint — No. of data points____________

Temperature sensitive paint — No. of data points____________

Acoustic — No. of data points____________

Flow visualization

Type: Surface flow Off-body

Describe requirement:

Other data requirements:

Classification requirements

Test Conditions:

Mach number schedule:	Reynolds number schedule
Dynamic Pressure(s)	Angle of attack schedule
Angle of side slip schedule	Nozzle pressure ratio schedule
Weight flow schedule (inlet)	

Other: Include detailed test matrix as enclosure if known

Instrumentation Requirements

Facility supplied

User supplied

Special Requirements

High pressure air pressure level and mass flow rate), exhaust (vacuum level and mass flow rate), cooling (temperature, water or air with mass flow rates), heating requirements, unique systems, additional space, remote access control room, hydraulics, (pressure level and flows), steam special data reduction requirements (plotting, format, etc.), know facility modifications required to accommodate test apparatus, etc.

Request Submitted: (Date M/D/Y)

Figure C-1: Test Request Form (Sheet 3 of 3)

C.3 Initial Test Planning Meeting Guide

Description

This guide is used by both the Customer and the Test Manager to set the agenda for the Initial Test Planning meeting. An example is shown in Figure C-2.

INITIAL TEST PLANNING MEETING GUIDE

(Address specific concerns & issues during appropriate sections)

I.OPENING (Test Manager)

1. Introduction of user representatives.
2. Introduce key Ames personnel.
3. Explain Ames' role regarding this test. (Including staffing)
4. State test date, prep room availability, 8 occupancy hours/shifts per day.
5. Restate required/updated dates for stress, program, stings, model.

II.TEST OVERVIEW&OBJECTIVES [Customer representative(s)]

- Three copies of the pretest report provided one week prior to the meeting.
- No questions from the field on other matters allowed! Only clarifications.

1. Test program overview and objectives.
2. Ames specific objectives & requirements. (Drag, S&C, pressure/loads...)
3. Sponsoring agency/Co-op & security classifications, if any.
4. Review present run schedule. (stream, high Rn, bridging, expected loads) - What are the real alpha schedule requirements-angles or increments?

III. MODEL HARDWARE DESCRIPTION [Customer representative(s)]

1. Support system:
- Whose stings & adapters. (what is total length & tunnel stations)
- Status/locations of pieces and tapers. (are gauges needed?, time frames)
- Has aerodynamic interference been investigated?

2. Model description:
- Scale, blockage, & pertinent dimensions. (Include drawing if appropriate)
- High pressure air & hydraulics requirements.
- Control surface inputs/requirements. (Manual or remote)
(Cover remote surface power/signal specs in section IV)
- Level plate specifics. (Size, weight, good at phi = 0, 90, 180 deg. as app.)
- Special fixtures for check loading etc.
- Boundary trip kind, sizing & application pattern. How long to apply?

3. Overall stress requirement satisfaction: (Receive preliminary section 5.0).
- What conditions are loads based on; theoretical or previous data?
- Model & sting assembly: (what parts have S.F. < 4 & 3 on ult. & yield?)
- Any exposed welds that are not otherwise bolted in. (inspect. req'd)
- Screw/bolt/pin certification. (unopened boxes plus lot inspections)
- Hardness checks/requirements.

Figure C-2: Initial Test Planning Meeting Guide (Sheet 1 of 2)

- Countersinks (inspections at Ames)
- Support system: Will any stings/adapters need special inspections?
- Balance inner rod safety factor. (catastrophic > 3.0)
- Proof loading requirements.
- We need estimated sting assy deflection & lift curve slopes, & ref area.

IV. INSTRUMENTATION (Test Manager or instrument engineer)

1. Balance: How was it sized? (supplier & backup)
- Calibration (by who, load range, delivery format for Ames....)
- Status of internal thermocouples.
- State our realtime, BLAMS & Oscillograph monitoring capabilities.
2. Angle of attack: Sources (how many, main, supplier, conditioning....)
3. Pressures: PSI's or individual transducers. (who will supply, size, kind....)
- Location (model or strut) (how are base & cavity read?)
- Reference, monitor requirements, port assignments etc.
- Tubing: Number, size, kind, supplier...
4. Thermocouples. (additionals & type if applicable)
5. Position indicators. (if applicable)
6. Buffet gauges, accelerometers, RMS system, & other unique reqm'nts.
7. Photo/video requirements.
- Flow visualization requirements. (Schlieren, oil flow, sublimation, etc.)
8. Cable routing, (internal or external to sting assembly) & length.

V. DATA PROCESSING (Test Manager or DPG representative)

1. Equations & corrections: Test equations supplied by NASA or Customer?
- Base, cavity, duct, mass flow, pressure integrations, RMS, etc....
- Stream angle, wall, buoyancy, Mach table & blockage corrections.
- Coeff axes, output (line printer) format-if any.
- Display &/or monitoring requirements.
- Sampling rates & duration. (frequency response required)
2. Plotting requirements: DPS
3. User computer: Kind and link type. (Decnet or TCP/IP, address)
- Data flow format (CDDMS) and frequency.
- Final transmittal medium and format (End of test & at 2 weeks post)

VI.SECURITY (Test Manager or security representative)

1. Classification: Computed & raw data, DGP, model, pictures, etc....
2. Facility lock up, padlocks, combinations, main entrance, guards.....
3. Access list, changes, escorting, data storage.
4. Data cleansing requirements (test directory only, or entire disk pack)

VII. SUMMARY & ACTION ITEMS (Test Manager)

1. Review & summarize all action items and dates due.
- Schedule, hardware, instrumentation, data reduction.

Figure C-2: Initial Test Planning Meeting Guide (Sheet 2 of 2)

C.4 Test Requirements Document Outline

Description

This outline is used by both the Customer and the Test Manager to delineate the requirements and objectives of the Customer. An example is shown in Figure C-3.

TEST REQUIREMENTS DOCUMENT

I TEST PROGRAM OVERVIEW
- a) Program objectives
- b) Program schedule

II TEST OBJECTIVES at AMES
- a) Contractor Requirements
- b) Drag, Stability & Control
- c) Pressure Information
- d) Run Schedule - Priorities, Procedures, Configuration Codes
- e) Test Support, Contacts, Addresses & Phone Numbers

III MODEL & HARDWARE DESCRIPTION
- a) Sting Hardware Assembly & Distortion
- b) Model Sizing
- c) Control Surfaces
- d) Area Distributions
- e) Parts/Drawings list
- f) Loads Sources & Estimates
- g) Boundary Trip Sizing, Application & Philosophy
- h) Model Instrumentation and tap locations

IV INSTRUMENTATION
- a) Balance - Description, Capacity, Calibration, Backup, pin hole
- b) Angle of Attack source(s) and locations
- c) Pressure Instrumentation, Kinds, and Port Assignments
- d) Thermocouples, Position pots, Strain Gauges & Others
- e) Flow Visualization, Photo & Video

V DATA PROCESSING
- a) Ames Corrections - Base, Cavity, Buoyancy, Stream, wall, etc.
- b) User Corrections - to be applied by Ames computing software
- c) Nomenclature used and Required
- d) Parameters - comprehensive
- e) Accuracies, Repeatability & Tolerances
- f) Computer Hookups, Data Flow Format
- g) Output Formatting & Plotting

Figure C-3: Test Requirements Document Outline (Sheet 1 of 2)

VI SECURITY (if applicable)

a) Facility - Tunnel & Prep Room
b) Model, Photographs, Video
c) Computed, Real-time & Raw Data

Drawings, Charts & Tables may be included in the text or as Appendices.

Figure C-3: Test Requirements Document Outline (Sheet 2 of 2)

Appendix D 12ft PWT, Instrumentation, Data Acquisition, and Data Reduction

Introduction

Ames can provide sensors, instrumentation, data systems, and the necessary engineering and technician personnel for obtaining tunnel conditions, forces, pressures, temperatures, flow visualization, and model attitude data. This section describes standard sensors, instrumentation and data systems available for supporting both test preparation and testing at the 12ft PWT.

Sensors

All Ames supplied sensors must be reserved well in advance of the actual test. Customers should address their needs at the initial test planning meeting so requirements for measurements can be clearly identified.

If the available standard instrumentation resident at the facility is insufficient to meet the objectives of a specific test, the Ames Test Manager shall be notified before the initial test planning meeting of special requirements. Existing resident systems can be expanded or modified, and special instrumentation can be added.

It is important for customers to be aware that customer supplied equipment placed inside the pressure vessel (test section and plenum) of the 12ft PWT will be subjected to pressures from sub-atmosphere to six atmospheres and will be exposed to rapid changes in pressure and temperature during pressurization and depressurization of the test section.

Instrumentation Wiring, pneumatics, And Fiber Optics

A dedicated control room is located adjacent to the Wind Tunnel Test Section. The control room is linked to the various model support systems inside the test section pressure vessel area with a limited amount of test dependent instrumentation wiring, plumbing, and fiber optics terminated in patch panels in the control room and inside the pressure vessel. Even though the physical distance between the test section and the control room is relatively short, the physical path followed by the test dependent instrumentation wiring, plumbing and fiber optics is substantially longer in order to accommodate the test section rotation capability. Customer supplied signal conditioning will need to be compatible with these long line lengths.

Control Room

The 12ft PWT control room is equipped with a standard set of instrumentation, data acquisition, and data analysis equipment optimized for production, pitch/pause force and moment testing in conjunction with simultaneous steady state surface pressure measurements. A portion of the control room is reserved for customer supplied equipment and customer personnel to participate with the Ames supplied personnel in the conduct of the test. The control room data system is intended for acquisition, data recording, data display, and a limited amount of data analysis. The data system has no capabilities for test dependent model controls and is not suited for dynamic data acquisition needs.

The control room is equipped with a closed circuit video system for observing the test article during running. A limited amount of video and photographic recording equipment is available. Customers should address their needs at the initial test planning meeting.

The control room data system is linked to a local Wind Tunnel network not accessible from the Internet. Remote access to the data system can be made through the use of the NASA Aeronet limited access network. Access to the Internet for customer supplied computers is available in the control room. Access to the control room data system from customer supplied analysis computers is also available. However, connection of customer computers to both the Internet and the control room data system is not allowed. Control room space utilization, interfaces with the 12ft PWT standard equipment, and network interfaces required by the customer should be addressed at the initial test planning meeting. Use of the remote access capability will require special coordination to meet all security needs.

Model Preparation Sites

Two fully equipped Model preparation sites are available to customers of the 12ft PWT facility. Equipment at these sites allow complete model/balance/model support configurations to be assembled and all model based sensor, instrumentation, and control systems to be verified prior to test section occupancy. Each model preparation site has an identical data acquisition system available in the control room. The model preparation areas are equipped with wiring, plumbing, and optical interfaces which emulate the services available in the control room and test section. Each model preparation site is equipped with a customer office. Customer supplied data analysis systems and model control systems can be interfaced and tested with the model preparation site resources. Network services and restrictions are similar to those for the control room. Test dependent wiring can be assembled in the model prep rooms. Prep rooms are stocked with basic parts, tools, and materials. Tasks and required resources for model buildup should be addressed at the initial test planning meeting.

D.1 Sensors Available at Ames

Force Balances

Ames has six-component multi-piece internal strain-gage balances with normal force capacities from 5 to 6,000 pounds, five-component balances for semispan testing with normal force capacities from 6,000 to 40,000 pounds, and a small number of specialty balances. Balances are listed in Table D-1, Table D-2, and Table D-3.

Requests and reservations for use of these balances must be established at the initial test planning meeting to minimize conflicts in scheduling and calibrations. Ames can also calibrate customer balances.

Table D-1: Six-Component Internal Sting Balances (Task-Able)

	Gauge capacities					
Balance (diameter, inches)	**N1 (lbs)**	**N2 (lbs)**	**S1 (lbs)**	**S2 (lbs)**	**A (lbs)**	**RM (in-lbs)**
T-0.75 XIIA,B	5	5	2.5	2.5	10	10
T-0.75 XVA	100	100	50	50	30	100
T-0.75 XVIIIA	100	100	50	50	60	60
T-0.75 XXA,B,C	25	25	12.5	12.5	50	25
T-0.75 XXIXA	167	167	83.3	83.3	83.3	25
T-0.75 XXIXB	167	167	83.3	83.3	25	25
T-0.75 XXXIIA,B	5	5	5	5	10	10
T-0.75 XXXIIIA	100	100	50	50	20	60
T-0.75 XXXIVA	100	100	50	50	20	60
T-0.75 XLIA	100	100	50	50	30	100
T-1.00 IVA	125	125	125	125	250	250
T-1.00 VA	200	200	200	200	200	200
T-1.00 VIA	400	400	200	200	40	100
T-1.00 XIVA,B,C	400	400	200	200	100	250
T-1.50 IIB,D	500	500	250	250	300	800

Table D-1: Six-Component Internal Sting Balances (Task-Able)

	Gauge capacities					
Balance (diameter, inches)	**N1 (lbs)**	**N2 (lbs)**	**S1 (lbs)**	**S2 (lbs)**	**A (lbs)**	**RM (in-lbs)**
T-1.50 IIC,E	500	500	250	250	100	800
T-1.50 XIIA	500	500	250	250	300	800
T-1.50 XIIIA	1000	1000	500	500	2000	500
T-1.50 XIXA	400	400	50	50	250	50
T-1.50 XXVIA	1000	1000	800	800	2000	700
T-1.75 IB	2000	2000	2000	2000	3000	1000
T-2.00 IA	900	900	450	450	160	1000
T-2.00 IIIC	900	900	450	450	500	1000
T-2.00 IIIE,F	900	900	450	450	160	1000
T-2.00 IXA	900	900	450	450	500	1000
T-2.00 XIIA	1500	1500	800	800	200	2000
T-2.00 XIVA	1500	1500	800	800	300	2000
T-2.00 XXIXA,B	2100	2100	700	700	350	3800
T-2.50 IIIA,B,D	1400	1400	700	700	280	2000
T-2.50 IVA,B	1400	1400	700	700	200	2000
T.2-50 XIA	1700	1700	700	700	1000	2000
T-2.50 XIVA	3600	3600	1800	1800	4000	1600
T-2.50 XVA	2000	2000	1000	1000	800	2000
T-2.50 XVIA	2400	2400	1200	1200	1500	4000
T-2.50 XXA,B	3000	3000	1500	1500	600	4000
T-2.50 XXXIIA	3000	3000	1500	1500	250	3000
T-2.50 XXXIVA,B	3500	3500	1800	1800	400	5000
T-2.50 XLA	3500	3500	2500	2500	400	8000
T-4.00 IIA	4000	4000	2000	2000	1000	16000
T-4.00 IIB	4000	4000	2000	2000	400	10000
T-4.00 IIC	4000	4000	2000	2000	1000	16000
T-4.00 IVA	6000	6000	3000	3000	2500	16000

Table D-2: Five-component Floor Balance

	Gauge capacities				
	NF	PM	AF	YM	RM
Balance	(lbs)	(ft-lbs)	(lbs)	(ft-lbs)	(ft-lbs)
MC-60-27.50A	6,000	3,000	1,200	6,000	30,000
MC-15-27.50A	15,000	10,000	3,000	15,000	75,000
MC-400-27.50A	40,000	20,000	8,000	40,000	190,000

Pressure Measurements

Model surface pressures are measured with Electronically Scanned Pressure (ESP) scanners manufactured by Pressure Systems, Incorporated (PSI). Available scanners are 16, 32, 48, and 64 transducers per unit and pressure ranges from 10 inches of water to 100 psid. Scanners with purge option, with straight or slant input ports are available. Scanner pressure ranges are listed in Table D-3.

Scanners can be equipped with a purge option (used for blowing out air from model orifices when Pressure Sensitive Paint or oil flow liquids are applied).

Table D-3: PSI Pressure Scanner Ranges

PSI Scanners
10" H_2O
20" H_2O
1 psid
2.5 psid
5 psid
30 psid
50 psid
100 psid

As shown in Table D-4, a limited number of discrete pressure transducers are available.

Table D-4: Examples of discrete pressure transducers available

Type	Pressure Range, psia or psid	%FS Accuracy	Output
Paroscientific Model 1000	3000, 100, 45, 23 psia. 18, 6, 3 psid.	0.01	RS232
Bourns Model ST4140	500, 1000, 1500, 2000, 3000 psia	0.25	0 to 5 vdc
Setra Model 205-2	50, 100 psia	0.10	0 to 5 vdc

Tilt Sensors

Ames has gravity-based tilt sensors available for angle of attack measurements. These are summarized in Table D-5 below.

Table D-5: Tilt Sensors Available

Type	Angle Range, degrees	Output
Schaevitz LSCV-1556	±14.5, ±30	±5 vdc
Columbia SI-111311	±15	±5 vdc
Spectron L210R-557A w/ MUPI2	±1, ±30	±5 vdc

D.2 Institutional (Instrumentation) Cables, Pneumatics, and Fiber Optics

Description

The institutional wiring runs from the control room into termination cabinets inside the tunnel plenum. The two main sets of instrumentation lines are Turntable (TRN) and Rear Sting Support (RSS). The instrumentation lines for the TRN split to two different instrumentation cabinets that are the Bi-Pod Model Support (BMS) and the High Angle of Attack Model Support (HAA). All of the wiring available from the control room can be connected all the way to the BMS. However, only a portion of the control room to TRN wiring can be extended to the HAA model support (see Figure D-1).

Table D-7 through Table D-11 show the instrumentation capabilities of the various model support systems. Figure D-1 shows the block diagram of the locations.

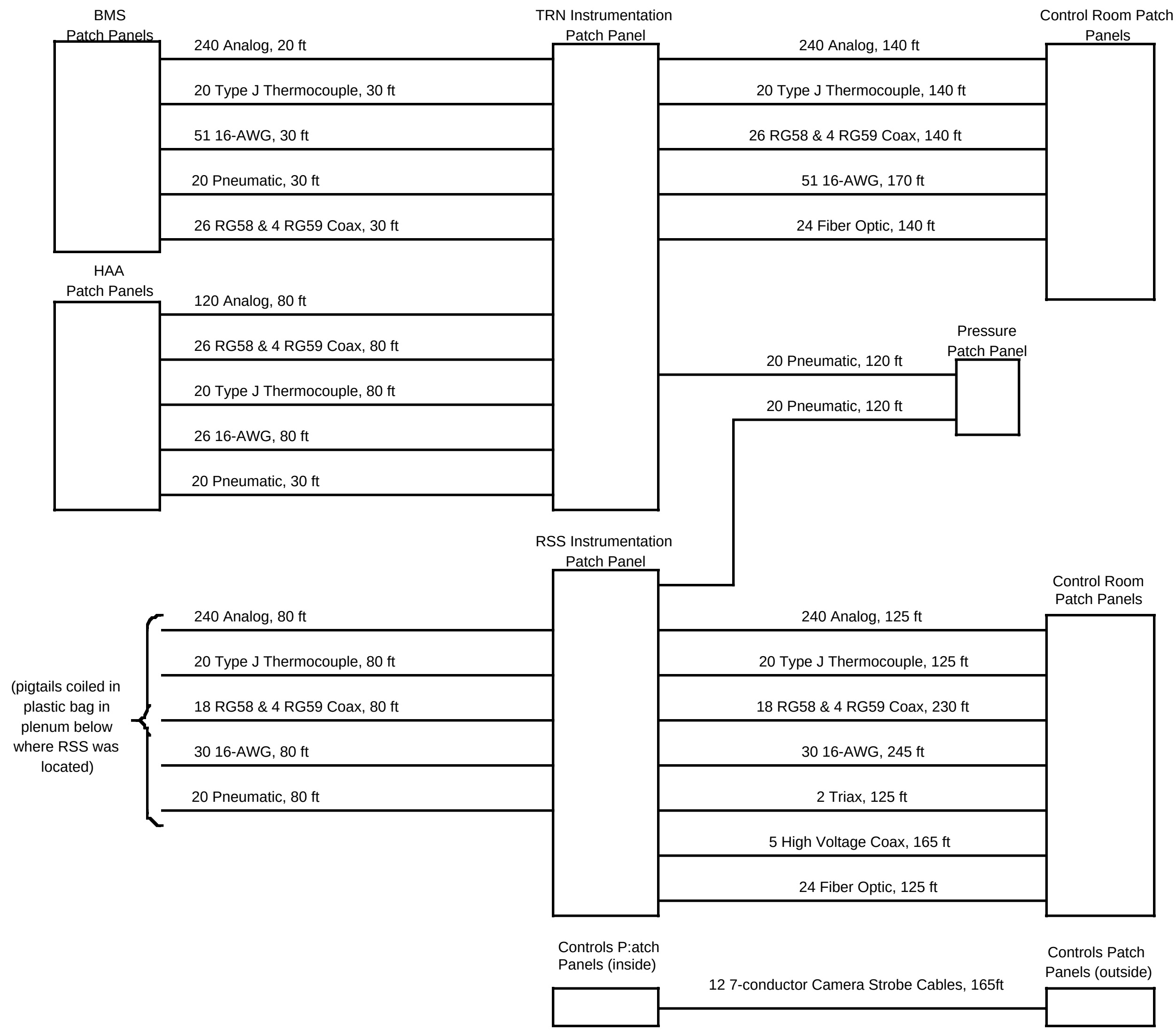

Figure D-1: Block Diagram for 12ft PWT Institutional Wiring

Table D-7: Turntable Model Support (TRN)

Class	**Qty**	**Type**	**Mfg P/N** (length in feet)	**Tunnel Patch Panel Receptacle Mate (Receptacle P/N)**	**Control Room Receptacle Mate (Receptacle P/N)**
Analog Signals	240 (40 are used for PSI) 120 to BMS, 120 to HAA	4-cond 22 AWG shld	Belden 8723 (outside), length: 90 Belden 83349 (inside) lengths: BMS: 70, HAA: 130	Taper pin AMP 41666 (60 position taper pin block AMP 3-582521)	Circular connector MS3474A12-10P (MS3474L12-10S)

Table D-7: Turntable Model Support (TRN)

Class	Qty	Type	Mfg P/N (length in feet)	Tunnel Patch Panel Receptacle Mate (Receptacle P/N)	Control Room Receptacle Mate (Receptacle P/N)
Thermocouple	20 qtys can be distributed to BMS or HAA	Type J 20 AWG T/C shld	Belden 1000 (outside), length: 90 Belden 83950 (inside) lengths: BMS: 70, HAA: 130	Strip wire & insert (Phoenix Contact Terminal Blocks MTKD-FE/CUNI Type J)	(3 prong T/C jack, Omega 19TJP-1-20-J)
Heavy Gage Wires for Model Motors and Control	51 conductors (6 are used for PSI, 21 are used for other functions)	2-cond 16 AWG shld	Belden 9952 lengths: BMS: 200, HAA: 250	Strip wire & insert Phoenix Contact Terminal Blocks	Strip wire & insert Phoenix Contact Terminal Blocks
Pneumatic Tubing	20 (6 are used for PSI) qtys can be distributed to BMS or HAA	1/4 inch dia nylon pneumatic tubing	Freelin-Wade lengths: BMS: 120, HAA: 170	1/4 inch dia Swagelok Bulkhead Union SS-400-61	1/4 inch dia Swagelok Bulkhead Union SS-400-61
RG58 Coax	26 (12 are used) qtys can be distributed to BMS or HAA	RG58 50-ohm coax	Belden 9203 lengths: BMS: 170, HAA: 220	(BNC coax connector, Phoenix Contact BNC-V 50)	(BNC coax connector, Phoenix Contact BNC-V 50)
RG59 Coax	4 qtys can be distributed to BMS or HAA	RG59 75-ohm coax	Belden 9259 lengths: BMS: 170, HAA: 220	(BNC coax connector, Phoenix Contact BNC-V 75)	(BNC coax connector, Phoenix Contact BNC-V 75)
Fiber Optic	24 fibers	Fiber Optic, 50 micron	Belden 227304 length: 140	Terminates in cabinet before BMS and HAA cabinets Type ST Connectors	Type ST Connectors

Table D-8: Bi-Pod Model Support (BMS) to Control Room

Class	Qty	Type	Mfg P/N (length in feet)	Tunnel Patch Panel Receptacle Mate (Receptacle P/N)	Control Room Receptacle Mate (Receptacle P/N)
Analog Signals	240 (40 are used for PSI) 120 to BMS 120 to HAA	4-cond 22 AWG shld	Belden 8723 (outside), length: 90 Belden 83349 (inside) length: 70	Taper pin AMP 41666 (60 position taper pin block AMP 3-582521)	Circular connector MS3474A12-10P (MS3474L12-10S)
Thermocouple	20	Type J 20 AWG T/C shld	Belden 1000 (outside), length: 90 Belden 83950 (inside) length: 70	Strip wire & insert (Phoenix Contact Terminal Blocks MTKD-FE/CUNI Type J)	(3 prong T/C jack, Omega 19TJP-1-20-J)

Table D-8: Bi-Pod Model Support (BMS) to Control Room

Class	Qty	Type	Mfg P/N (length in feet)	Tunnel Patch Panel Receptacle Mate (Receptacle P/N)	Control Room Receptacle Mate (Receptacle P/N)
Heavy Gage Wires for Model Motors and Control	51 conductors (6 are used for PSI, 21 are used for other functions)	2-cond 16 AWG shld	Belden 9952 length: 200	Strip wire & insert Phoenix Contact Terminal Blocks	Strip wire & insert Phoenix Contact Terminal Blocks
Pneumatic Tubing	20 (6 are used for PSI)	1/4 inch dia polyurethane pneumatic tubing	Freelin-Wade 1B-025-27 length: 120	1/4 inch dia Swagelok Bulkhead Union SS-400-61	1/4 inch dia Swagelok Bulkhead Union SS-400-61
RG58 Coax	26 (12 are used)	RG58 50-ohm coax	Belden 9203 length: 170	(BNC coax connector, Phoenix Contact BNC-V 50)	(BNC coax connector, Phoenix Contact BNC-V 50)
RG59 Coax	4	RG59 75-ohm coax	Belden 9259 length: 170	(BNC coax connector, Phoenix Contact BNC-V 75)	(BNC coax connector, Phoenix Contact BNC-V 75)

Table D-9: High Angle of Attack Model Support (HAA) to Control Room

Class	Qty	Type	Mfg P/N (length in feet)	Tunnel Patch Panel Receptacle Mate (Receptacle P/N)	Control Room Receptacle Mate (Receptacle P/N)
Analog Signals	120 (40 are used for PSI)	4-cond 22 AWG shld	Belden 8723 (outside), length: 90 Belden 83349 (inside) length: 130	Taper pin AMP 41666 (60 position taper pin block AMP 3-582521)	Circular connector MS3474A12-10P (MS3474L12-10S)
Thermocouple	20	Type J 20 AWG T/C shld	Belden 1000 (outside), length: 90 Belden 83950 (inside) length: 130	Strip wire & insert (Phoenix Contact Terminal Blocks MTKD-FE/CUNI Type J)	(3 prong T/C jack, Omega 19TJP-1-20-J)
Heavy Gage Wires for Model Motors and Control	26 conductors	2-cond 16 AWG shld	Belden 9952 length: 250	Strip wire & insert Phoenix Contact Terminal Blocks	Strip wire & insert Phoenix Contact Terminal Blocks
Pneumatic Tubing	20 (6 are used for PSI)	1/4 inch dia polyurethane pneumatic tubing	Freelin-Wade 1B-025-27 length: 170	1/4 inch dia Swagelok Bulkhead Union SS-400-61	1/4 inch dia Swagelok Bulkhead Union SS-400-61

Table D-9: High Angle of Attack Model Support (HAA) to Control Room

Class	Qty	Type	Mfg P/N (length in feet)	Tunnel Patch Panel Receptacle Mate (Receptacle P/N)	Control Room Receptacle Mate (Receptacle P/N)
RG58 Coax	26 (12 are used)	RG58 50-ohm coax	Belden 9203 length: 220	(BNC coax connector, Phoenix Contact BNC-V 50)	(BNC coax connector, Phoenix Contact BNC-V 50)
RG59 Coax	4	RG59 75-ohm coax	Belden 9259 length: 220	(BNC coax connector, Phoenix Contact BNC-V 75)	(BNC coax connector, Phoenix Contact BNC-V 75)

NOTE

The RSS is not currently in place but the wiring and tubing can be used for items that are plenum-based.

Table D-10: Rear Sting Support, (RSS)

Class	Qty	Type	Mfg P/N (length in feet)	Tunnel Patch Panel Receptacle Mate (Receptacle P/N)	Control Room Receptacle Mate (Receptacle P/N)
Analog Signals	240 (62 are used for PSI and discrete pressure measurements)	4-cond 22 AWG shld	Belden 8723 (outside), length: 75 Belden 83349 (inside) length: 130	(pigtails coiled in plastic bag in plenum)	Circular connector MS3474A12-10P (MS3474L12-10S)
Thermocouple	20 (4 are used for PSI scanner temperatures)	Type J 20 AWG T/C shld	Belden 1000 (outside), length: 75 Belden 83950 (inside) length: 130	(pigtails coiled in plastic bag in plenum)	(3 prong T/C jack, Omega 19TJP-1-20-J)
Heavy Gage Wires for Model Motors and Control	30 conductors (6 are used for PSI)	2-cond 16 AWG shld	Belden 9952 length: 245	Strip wire & insert Phoenix Contact Terminal Blocks	Strip wire & insert Phoenix Contact Terminal Blocks
Pneumatic Tubing	20 (6 are used for PSI)	1/4 inch dia polyurethane pneumatic tubing	Freelin-Wade 1B-025-27 length: 195	1/4 inch dia Swagelok Bulkhead Union SS-400-61	1/4 inch dia Swagelok Bulkhead Union SS-400-61
RG58 Coax	18	RG58 50-ohm coax	Belden 9203 length: 230	(BNC coax connector)	(BNC coax connector, Phoenix Contact BNC-V 50)

Table D-10: Rear Sting Support, (RSS)

Class	**Qty**	**Type**	**Mfg P/N** (length in feet)	**Tunnel Patch Panel Receptacle Mate (Receptacle P/N)**	**Control Room Receptacle Mate (Receptacle P/N)**
RG59 Coax	4	RG59 75-ohm coax	Belden 9259 length: 230	(BNC coax connector)	(BNC coax connector, Phoenix Contact BNC-V 75)
Double-Shielded Coax	2	75-ohm triaxial double shld cable	Belden 9248 length: 150	Trompeter triax connector UBJ28 w/ UPL-20-4 cable plugs	Trompeter triax connector UBJ28 w/ UPL-20-4 cable plugs
Fiber Optic	24	Fiber Optic V1-	Belden 227304 length: 150	MA COM LCS, ST Style Multimode Fiber Optic Connector, P/N 3STMM125LCS	MA COM LCS, ST Style Multimode Fiber Optic Connector, P/N 3STMM125LCS
High Voltage Coax	5	High Voltage Coax	Belden 8261 length: 165	Kings HV Coax Connector 1705-7	Kings HV Coax Connector 1705-7 (terminates at Plenum Utilities Termination Cabinet

Table D-11: Camera Strobe Cables

Class	**Qty**	**Type**	**Mfg P/N** (length in feet)	**Tunnel Patch Panel Receptacle Mate (Receptacle P/N)**	**Control Room Receptacle Mate (Receptacle P/N)**
Heavy Gage Cables for Camera Strobes	12	7-cond 16 AWG cable	Belden 85107 length: 165	Strip wire & insert Phoenix Contact Terminal Blocks	Strip wire & insert Phoenix Contact Terminal Blocks

D.3 Data Acquisition

Functional Subsystems

Seven different Functional Subsystems are used as the front ends for data acquisition of the Standardized Data System (SDS). The Functional Subsystems are signal conditioning and digitizers controlled by a PC. The seven functional classes associated are (refer to Figure D-2):

- Force balances
- Steady-state surface pressures (PSI 8400)
- General purpose digital input (under construction)
- Temperatures

- General purpose analog inputs
- Tunnel conditions and model attitude support positions
- Wall Interference Correction System (WICS)

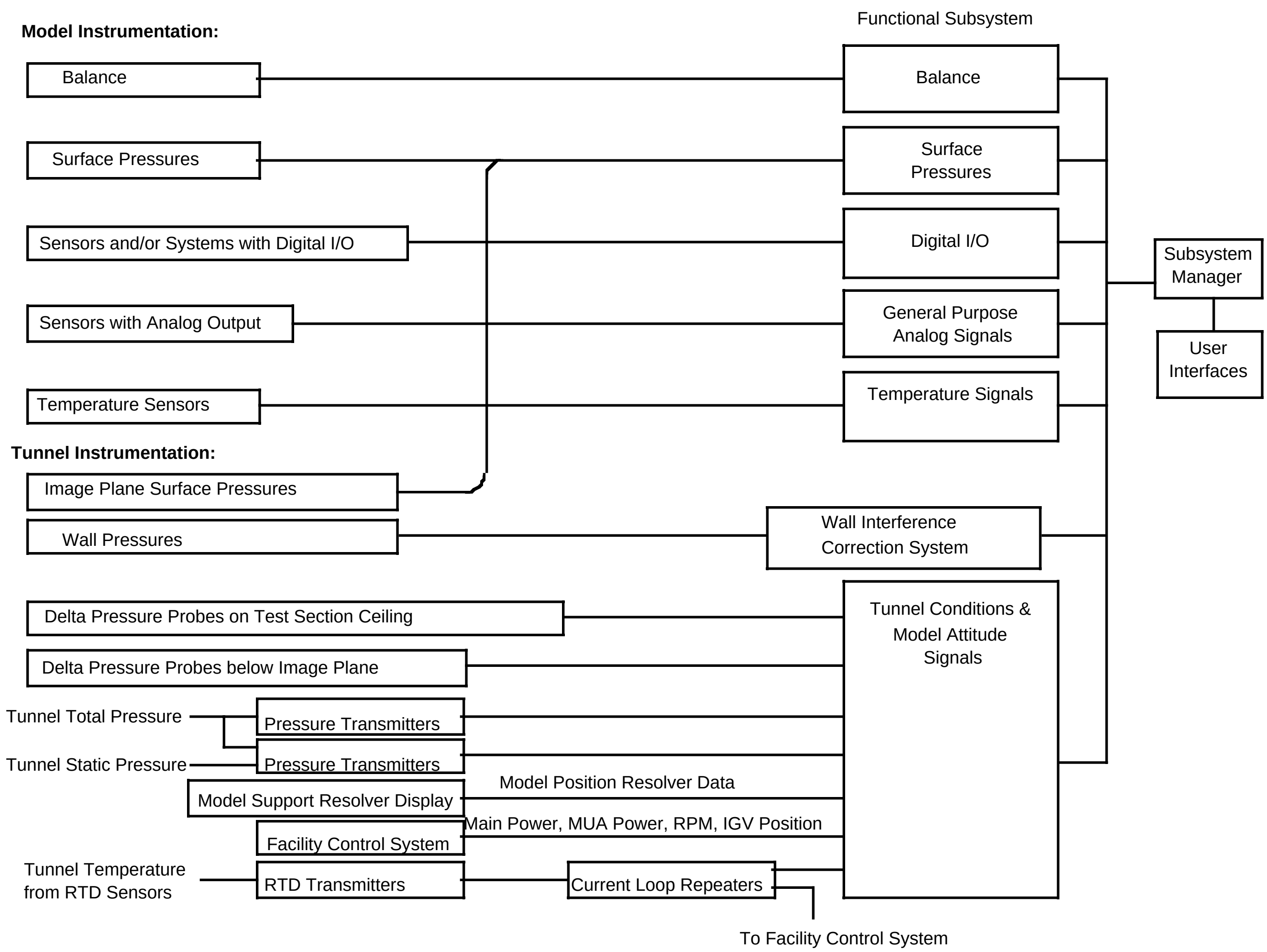

Figure D-2**:** Block Diagram for Inputs to the Standardized Data System (SDS)

Force Balances

Up to 32 channels of balance strain gages can be measured by the signal conditioning amplifiers of Functional Subsystem #1. The amplifiers provide up to 10 volts DC excitation and gains from 1 to 1024. Cutoff frequencies for filtering are 1, 10, 30, 100, 1000, 2000, 20000 Hz, and wideband. All filters are 4 pole Butterworth. All functions are computer controlled

Balance dynamics are displayed realtime on the Balance Loads Alarm Monitor System (BLAMS). The purpose of the BLAMS is to protect the delicate and expensive wind tunnel balances used at

Ames. In the 12ft PWT, it is programmed to zero the model angle-of-attack mechanism if any channel exceeds its limits for a pre-determined percentage of a variable time interval. The control room is equipped with a BLAMS unit to monitor up to eight balance channels.

General Purpose Digital Input

Under construction

Temperatures

Functional Subsystem #4 uses a VXI-based scanning A/D card for temperature signal inputs from a variety of thermocouple, RTDs, and thermistors as listed in Table D-12.

20 type J (Iron Constantan) thermocouples can be measured using the facility institutional thermocouple wiring.

An additional 47 thermocouple sensors of any standard type can be connected to a remote reference junction box inside the 12ft PWT plenum. The signals can then be routed to the control room using the institutional instrumentation wiring. These signals would then be patched to the temperature subsystem with the scanning A/D card. The reference thermistor for the scanning A/D card supporting these additional 47 thermocouples is on the reference junction box inside the plenum.

Up to 24 channels of a combination of 4-wire RTDs and 4-wire thermistors can be routed to Functional Subsystem #4 in the control room using the institutional instrumentation wiring. These signals would then be patched to the Functional Subsystem #4 chassis with the scanning A/D cards.

Table D-12: Compatible Temperature Signal Types

Thermocouple	RTD, 4-wire	Thermistor, 4-wire
E	100 ohm Type 85	2252 ohm
E ext	100 ohm Type 92	5Kohm
J		10Kohm

General Purpose Analog Inputs

The 12ft PWT analog conditioning system can accommodate 48 channels of a variety of customer-supplied analog signals such as position pots, discrete transducers, strain gages, or outputs from customer amplifiers. The analog system can provide excitation, amplification, and filtering for each channel.

The general analog amplifier racks provide up to 10 volts DC excitation and accepts inputs ±10 volt DC maximum. Discrete power supplies provide excitations up to 24 VDC.

The gain of each channel is programmable from 1 to 1024. Cutoff frequencies for filtering are 1, 10, 30, 100, 1000, 2000, 20000 Hz, and wideband. All filters are 4 pole Butterworth.

Tunnel Conditions and Model Support Positions

Tunnel Conditions—Table D-13 shows the measurable parameters in the 12ft PWT.

Table D-13: Measured Tunnel Parameters

Parameter
Total Pressure*
Total minus Static Pressure*
Total Temperature*
240 Test Section Wall Pressures
Compressor RPM
Tunnel Main Power
Tunnel Inlet Guide Vane Position
Tunnel Make Up Air Power

* Each of these measurements have redundant sensors.

Model Attitude—The four model support systems are:

- Turn Table Model Support (TRN) for Semispan floor-mount models.
- Bi-pod Model Support (BMS) in lift, yaw, and pitch.
- High Angle of Attack Model Support (HAA) in roll, pitch, and yaw.
- Rear Sting Support (RSS), not currently installed.

Table D-14 delineates the model attitude data.

Table D-14: Model Attitude Data

PARAMETER	RSS	BMS	HAA	TRN
Roll	X		X	
Pitch	X	X	X	
Yaw (pitch for TRN)		X	X	X
Lift (up/down)	X	X		X

Each model support is equipped with a primary and redundant resolver for each degree of motion. The resolver signals are processed by a multi-channel resolver-to-digital converter system. These digitized resolver readings are then distributed to both the FCS and the SDS system (10 times per second) through independent RS-232 data streams.

An alternate source of angle of attack measurements can be made with, such as, gravity-based tilt sensors.

Wall Interference Correction System (WICS)

Functional Subsystem #7 is the Wall Interference Correction System at the 12 Foot PWT. It measures pressures from 240 wall orifices arranged in 8 rows of 30 pressures each oriented around the test section. Pressures are recorded and stored with the rest of the test dependent data. During the post-test period, these pressures are used along with a simplified representation of the model in terms of singularities, model lift force and pitching moment and previously acquired wind tunnel calibration data to determine a Mach number, dynamic pressure, and angle of attack correction to the SDS model data.

Wall pressures are measured with Electronically Scanned Pressure (EPS) scanners manufactured by Pressure Systems, Incorporated (PSI). The pressure range of the scanners are ±5-psid.

D.4 Image Plane Pressure Instrumentation

Description

A platform called the Image Plane, which also serves as the surface for semi-span models, can be placed on the floor of the 12ft PWT test section. There are approximately 240 surface pressure taps across the Image Plane. Two delta pressure (total minus static) probes, DP Probes, are mounted below the Image Plane. Two additional DP Probes, mounted on the ceiling inside the test section, are also used with the Image Plane.

D.5 Subsystem Management Processor

Description

The Subsystem Management Processor (SMP) is a UNIX based computer (SUN Sparc 10 for model preparation rooms and SUN Enterprise 3000 for the facility control room). Each SMP is equipped with removable disk drives, a CD ROM, and an 8mm 2GByte tape drive. The control room system is also equipped with a 14GByte DLT tape drive.

The SMP serves as the main executive to:

- collect the data from the FSPs
- set the time duration for recording of data
- perform data reduction
- serve as the primary customer interface
- provide hard copy output
- provide alpha-numeric and graphic displays on X-terminals
- provide tools that enable customers to trouble-shoot computations of both standard and customer supplied (test specific) equations
- network results to the customers computers
- download parameters and initial conditions to the Facility Control System (FCS)
- store the data, with parameters and final results in the data base

The SMP receives the signal to acquire data from the Facility Control System (FCS) or customer commanded input.

The SMP resides on a private, dedicated wind tunnel network. This network may be isolated to function only within the control room. The SMP is also on a second, separate network used to communicate with the FCS. This network leaves a path outside the control room to the adjacent auxiliary building. Security issues regarding secure tests are handled on a case-by-case basis.

D.6 Data Reduction

General

Data reduction is performed on the SMP computer and is defined as the process of producing engineering unit results from raw input data and the computational parameters. The SMP processes the data, stores the data received from the FSPs and computed results in the database, and outputs results to laser printers, real time displays, and other customer computers permitted on the system.

Data reduction requirements are determined by the computing specifications provided to the Wind Tunnel Systems staff by the Test Manager. These specifications define the test particulars required in order to set up and initialize all of the systems prior to either model prep room or control section entry.

The Test Manager must translate customer requirements into the SDS framework and submit a complete specification with sufficient lead time (which are a function of test complexity) to meet anticipated first use of the software. This requires the customer to provide all necessary information to meet these lead time requirements. The customer will be provided with the deadlines for submitting the test requirements at either the test justification or initial test planning meeting.

D.7 Available Processes

Real Time Displays

The SDS real time displays are available on X-terminals and are capable of updating two times per second, even while data recording is in progress. Any acquired raw data statistic (mean, min, max, etc.) from a sensor and computed result may be displayed. Displays are in the form of a name followed by its value. A maximum of 60 values are available on one window. Generic templates are provided for displaying items such as pressures from the electrically scanned pressure modules.

Customers may define and simultaneously view any number of real time displays.

Graphics

The Display Processor Subsystem (DPS) is used to provide near-time, interactive graphics support. Graphic functionality for the SDS system is supplied through X-terminals served by the SMP. Current plotting capability is limited to the generic x-y plots (i.e., no contour plotting) with various curve fairing options.

The primary purpose of the graphics support is for verification that all components of the instrumentation and data system are functioning properly, that the data are accurate and contain minimal scatter, and to provide some support for data analysis. It is not the intent of the graphics system to provide large numbers of report quality plots.

Data may be plotted in various ways. The two most commonly used are categorized as “Run” or “Point” type. A run-type plot produces one curve for the entire run, with up to 10 runs permitted per plot. A point-type plot produces a complete curve for every data point that is plotted. An example of a run-type plot is lift versus angle of attack. An example of a point-type plot is pressure coefficient versus chord station. Up to four different graphs may be plotted in the same X-terminal window.

Plotting may be done in what is termed “Near time mode”. When plotting in near term mode, the system will automatically plot the point as soon as it has been computed on the SMP. This mode of operation is useful to determine if sufficient data has been acquired to determine an effect, such as repeatability, and thus terminate the run to save time. Another useful feature is to determine if some piece of hardware on the model has unexpectedly changed angle, such as an aileron, so that the facility may be shut down.

Standard Computations

"Standard Computations" refers to those computations that do not have to be coded for each test entering the facility. These computations are defined in the Division document "Standard Data System Wind Tunnel Data Reduction Equations, High Speed Facilities". Standard computations are:

- Conversions from raw data (mean) to engineering units
- Tunnel conditions
- Balance loads, including weight tare corrections
- Angles in balance and body coordinates
- Coefficients in balance, body, stability, corrected body and wind axis systems
- Pressures in the form of engineering units, static pressure ratios, total pressure ratios, and coefficients
- Wall interference corrections using the method of Sivells and Salami and classical blockage correction using the method of NACA TR 995.

Test Specific Computations

Test specific (non-standard) computations are those not contained in the SDS standard computations package. Test specific computations must be programmed and verified for each test. Examples of non-standard computations are such things as mass flow, hinge moment coefficients, etc. Generally, as the number of test specific computations increase the lead time for submitting test requirements increases.

Output

Hard copy output is available in A/B format from black and white laser printers. Hard copy output is available for dumps of the real time display screen, plots from the graphics display system, and customer defined formatted data outputs.

D.8 Deliverables

Data Transmittal

Data written on electronically readable media are normally provided after the data have been certified by the Test Manager. Data transmittal is typically in the Ames standard format, but custom formats can be provided. The use of custom formats will take longer than the Ames standard, unless the customer has provided the specifics of the format prior to the start of the test.

The customer must supply the output format required (file structure), whether the transmittal should be on 4mm or 8mm tape, or by DLT 4000. Tapes will be written in TAR format.

Only data transmitted with an accompanying NASA letter head are considered the official, certified-correct version. This is also true for any data which might be transmitted to the customers computer in the control room or to a remote site over a network. This insures that the customer has data that are identical with that residing on the Ames Archive.

Security

The customer must specify the security nature of the data, both raw (mean) and computed results. Disposition of the data, both magnetic and paper must also be detailed. The Division takes every precaution to protect the proprietary nature of customer data. Only personnel having need have access to the data. Security requirements which must be provided are elements such as network security, shredding and burning of paper output, cleansing of the disk, disposition of backup media, etc.

The wind tunnel network is a private, dedicated network with no access to the Ames center-wide network. Communications outside the building may be disabled, except for the link between the SDS and the FCS. Network security issues should be addressed at the initial test planning meeting.